24th Biennial Conference on the Biology of Marine Mammals
Palm Beach, Florida • August 1-5, 2022

BOOK OF ABSTRACTS
Marine mammals live in a rapidly changing world and face a wide range of challenges and threats from both the natural environment and human actions. Science focused on marine mammals is addressing these challenges through new and advancing methodologies and techniques.

The conference theme, “A SEA CHANGE: Transforming Science into Stewardship”, highlighted the value of diversity in all forms in marine mammal science, from our multi-disciplinary approaches to the improvement of diversity in our field.
ABOUT SMM

The Society for Marine Mammalogy (SMM) was founded in San Francisco during the 4th Biennial Conference in 1981 and is the largest global organization of individuals interested in marine mammal research and conservation.

The mission of the SMM is to promote the global advancement of marine mammal science and contribute to its relevance and impact in education, science, conservation and management. The Society is also making important efforts to promote diversity and inclusion in STEM (Science, Technology, Engineering and Math) education.

The SMM holds its conference every two years to promote science, collaboration, and improve the quality of research on marine mammals around the globe. The 24th biennial conference will be held in Palm Beach, Florida at the Palm Beach Convention Center in December 2021.

“SMM2021 marks 40 years since the creation of our Society. In those four decades we have made amazing scientific discoveries, advanced technology, and tackled an ever growing list of conservation challenges. In Florida, we launch our next 40 years of growth and discovery and celebrate all the incredible work being done by our global community.”

- Charles Littnan, SMM President
SMM2022 CONFERENCE COMMITTEE

This conference would not have been possible without the hard work and dedication from our conference committees and volunteers!

ORGANIZING COMMITTEE
Charles Littnan - President SMM
Amy Hirons - Conference Co-Chair
Jeremy Kiszka - Conference Co-Chair
Mykenzee Munaco - Administrative Assistant
Michelle Caputo - Blue/Green Initiative Coordinator
Lori Polasek - Workshops Coordinator
Louisa Ponnampalam - Diversity Coordinator
Susana Caballero - Registration Coordinator
Yvanna Strait - Volunteer Coordinator
Jason Allen - Exhibit Co-Coordinator
James Thorson - Exhibit Co-Coordinator
David Rosen - Posters Coordinator
Kathleen Dudzinski - Opening & Closing Event Coordinator
Damian Lidgard - Video Submission Coordinator
Verena Gill - Last of The Right Whales Event
Jeremy Kiszka & Sascha Usenko - LGTBO+ Event
Jeremy Kiszka - Media Event Coordinator
Lucy Keith-Diagne - Int. Travel Grants Coordinator
Lindsay Porter - Awards and Judges Chair

STUDENT MEMBERS AT LARGE
SMAL committee was responsible for student travel grants, as well as planning the student night event.
Eric Angel Ramos
Ayça Eleman
Theresa-Anne Tatom-Naecker

SCIENTIFIC PROGRAM COMMITTEE
Stephen Trumble - Scientific Committee Co-chair
Sascha Usenko - Scientific Committee Co-chair
Sarah Kienle - Virtual Conference Chair

SCIENTIFIC THEME CHAIRS
Kathleen Dudzinski - Anatomy and Morphology
Caroline Casey - Behavior
Sarah Kienle - Ecology
Kathleen Hunt - Conservation
Allyson Hindle - Molecular / Cellular
Shane Kanatous - Physiology
Russell Fielding - Social Science

CONFERENCE CONSULTANTS
Jarrett Corke - SMM Conference Information and Technology Manager
Kim Rhodes - Maritz Global Events Conference Planner
Michael Smith - Maritz Global Events
Daniel Stone - Strategic Account Director
Daria Cohen - X-CD Technologies Inc.
Rebecca Takemoto - Syncopate Meetings & Events

“In a sea of change, be the change you wish to see.”
SMM2022 SPONSORS

On behalf of The Society for Marine Mammalogy and the entire conference committee for the 24th Biennial Conference on the Biology of Marine Mammals, we would like to thank all of our incredibly generous sponsors would have made this event possible!

PREMIERE SPONSORSHIP - BLUE WHALE - $75,000
HOLLY JOLLY FOUNDATION

PILOT WHALE - $25,000

BOTTLENOSE DOLPHIN - $15,000

MANATEE - $10,000

FINS AND FLIPPERS - < $10,000
OUR PLENARY SPEAKERS

SMM2022 plenary speakers included a world renowned oceanographer, distinguished college faculty and author, a microbiologist focused on conservation genetics and conservation veterinarian.

Dr. Sylvia Earle
Topic: Blue Hope: Exploring Earth’s Magnificent Oceans

We were thrilled to have our opening plenary keynote speaker be Dr. Sylvia Earle - President and Chairman of Mission Blue and a National Geographic Society Explorer in Residence. She is called “Her Deepness” by the New Yorker and the New York Times, “Living Legend” by the Library of Congress, and “First Hero for the Planet” by Time Magazine. She is an oceanographer, explorer, author and lecturer with a lifetime of experience as a field research scientist, government official, and director for corporate and non-profit organizations.

Michael Moore, Vet. MB. PhD
Director, Marine Mammal Center and Senior Scientist, Woods Hole Oceanographic Institution

Topic: The Changing Face of Whale Trauma: What We Know and Have to Do

Michael Castellini, PhD
Professor of Marine Biology and Dean of the School of Fisheries and Ocean Sciences, Emeritus, University of Alaska Fairbanks

Topic: Marine Mammal Stewardship at the Top and the Bottom of the World

Susana Caballero, PhD
Associate Professor, Biological Sciences Department, Universidad de los Andes

Topic: From genes to genomes to people: aquatic mammal science and conservation from a Latin American perspective

Nantarika Chansue, DVM. PhD
Director, Veterinary Medical Aquatic Animal Research Center, Chulalongkorn University

Topic: Marine Mammal Rescue with Limited Resources
A special thank you to all of the abstract reviewers that volunteered their time! Abstract reviewers play a vital role in supporting the SMM and elevating the quality of science presented at our conferences.

Reviewers are listed in alphabetical order.
Natalija Lace
Agnese Lanzetti
Finn Larsen
Matthew Lettrich
Charles Littnan
Lisa Loseto
Carley Lowe
Karen Lucchini
Vitor Luz Carvalho
Farzaneh Mansouri
Jennifer Maresh
Guilherme Maricato
Lori Marino
Arribart Marion
Sarah Marley
Letizia Marsili
Suleman Mazhar
Morgan McCarthy
Birgitte McDonald
Ashlie McIvor
Megan McKenna
Kel Mellilo-Sweeting
Daniela Mello
Jennifer Mendez
Karлина Merkens
Séverine Methion
Cristiane Kiyomi Miyaji Kolesnikovas
Maxine Montello
Eduardo Morteo
Dominik Nachtsheim
Manh Cuong Ngo
Kimberly Nielsen
Tenaya Norris
Ashley Noseworthy
Dara Orbach
Anna Osiecka
Mayuko Otsuki
D. Ann Pabst
Adam Pack
Cristina Panti
E.C.M. (Chris) Parsons
Maria Cecilia Passadore Real
Andrea Pereira
Robin Perrtree
Heather Pettis
Lindsay Porter
María José Pérez Alvarez
Sergi Pérez-Jorge
Nicola Quick
Ester Quintana-Rizzo
Nadya Ramirez-Martinez
Christian Ramp
Kimberly Raum-Suryan
Fiona Read
Kelly Robinson
Grisel Rodriguez
Emer Rogan
Jan Roletto
Errol Ronje
Naomi Rose
David Rosen
Debbie JF Russell
Mackenzie Russell
Simona Sacchini
Filipa Samarra
Michael D. Scott
Fannie Shabangu
Kara Shervanick
Isha Shyam
Ursula Siebert
Marije Siemensma
Ana Sirovic
Brandon Southall
Kamilla Souza
Stephanie Stack
Karen Stockin
Megan Stolen
Rhea L. Storlund
Florence Sullivan
Taryn Symon
Barbara Taylor
Jessica Taylor
Andrew Temple
Jennifer Tennesen
John M. Terhune
Outi Tervo
Steven Thornton
Philip Thorson
Nicole Todd
Leigh Torres
Juan Pablo Torres-Florez
Stephen Trumble
Jorge Urban
Sascha Usenko
Ana Valenzuela Toro
Sofie Van Parijs
Lara Vidal
Lorena Viloria Gomora
Emma Vogel
Gordon T. Waring
Amanda Warlick
Mason T. Weinrich
Paul Wensveen
Alexander Werth
Rosie Williams
Kenady Wilson
Christiana Wittmaack
Jamie N Womble
Carlos Francisco Yaipen-LLanos
David Yurkowski
Vera da Silva
Suzanne Manugian
Mariel ten Doeschate
SMM2022 JUDGES

A special thank you to all of the judges that volunteered their time! Judges are listed in alphabetical order.

Nicole Adimey
Juan José Alava
Jennifer Allen
Simon Allen
Shannon Barber-Meyer
Meghan Barboza
Luis Bedriñana
Kimberley Bennett
Jaime Bolaños-Jiménez
Daryl Boness
Amanda Bradford
Ing Chen
B. Louise Chilvers
Tommy Clay
Vicki Cornish
Tara Cox
Alissa Deming
Holly Edwards
David Ensminger
Nicola Erdsack
Vanessa Estrade
Carol Fairfield
Alyson Fleming
Thomas Ford
Stefanie Gazda
Verena Gill
Daniela Haro
Heather Hill
Amy C. Hirons
Lucy Keith-Diagne
Mandy Keogh
Jeremy Kiszka
Brian Chin Wing Kot
Douglas Krause
Erin LaBrecque
Natalija Lace
Charles Littnan
Kristy J. Long
Alex Loureiro
Maria Maust-Mohl
Wendy McFarlane
Daniela Mello
Erin Meyer-Gutbrod
Chiharu Mori
Eduardo Morteo
Leslie New
Mari Ochiai
Erin Oleson
Guy Oliver
Dara Orbach
D. Ann Pabst
E.C.M. (Chris) Parsons
Robin Perrtree
Cindy Peter
Katharina J. Peters
Lori Polasek
Corinne Pomerleau
Lindsay Porter
Kelsey Potlock
Ester Quintana-Rizzo
Javier S. Tellechea
Eduardo Secchi
Kim Shelden
Courtney Smith
Renata Sousa-Lima
Ebru Unal
Jonathan Vallarta
Jose Pablo Vazquez-Medina
Kathy Vigness-Raposa
Cecile Vincent
Mason T Weinrich
Alexander Werth
Kenady Wilson
Carlos Francisco Yaipen-LLanos
Jack Wei-Chieng Yang
SMM2022 ABSTRACTS:
ORAL, SPEEDTALK, VIDEO AND
POSTER PRESENTATIONS

The following is a list of all abstracts for oral, speedtalk, video and poster presentations that were presented at SMM2022. They are in alphabetical order based on presenting author.
Bryde’s whales recolonize the Bohol Sea, Philippines

Jo Marie Acebes1, Joshua Silberg2, Edna Sabater3, Angelico Tiongson4, Timothy Gardner5, Jean Asuncion Utzurrum6

1BALYENA.ORG, Marikina City, Philippines, 2Large Marine Vertebrates Research Institute Philippines, Jagna, Bohol, Philippines, 3Florida Institute of Technology, Philippines, 4Institute of Environmental and Marine Sciences, Silliman University, Dumaguete, Philippines, 5BALYENA.ORG, Worcester, MA, 6Silliman University, 6200 Dumaguete City, -- Select --, Philippines

Bryde’s whales (Balaenoptera edeni) were hunted in the Bohol Sea, Central Visayas, Philippines for much of the 19th and 20th centuries. Locally referred to as Bongkaras, whalers only distinguished one species caught. In 2008, based on an examination of skulls collected from various landing sites in the region, scientists discovered that Omura’s whales (Balaenoptera omurai) were also historically caught. Although local protection for all species of whales and dolphins has been in place since 1997, baleen whale encounters remain rare in the country. We documented 11 Bryde’s whale encounters in the Bohol Sea region from 2004 to 2021 based on boat-based surveys (n=10) and photographed sightings by tourists (n=1). None were distinguished as Omura’s whales although differentiating them in the field can be challenging. We identified six individual whales based on dorsal fin shape and markings. One photo-identified individual was seen three times in three different years (2017, 2019 and 2021). In 2019, this whale was seen accompanied by a calf. These sightings highlight the importance of continued monitoring of the Bohol Sea region for cetacean species that are poorly understood and were hunted in the past. With long-term monitoring through surveys, photo-identification, and genetics we can begin to understand the recovery status of Bryde’s-like whales in our waters.

Dysbiosis and cellular transformation of the California sea lion genital epithelium

Karina Acevedo-Whitehouse1, Juan Carlos Pereida-Aguilar1, Cecilia Barragán-Vargas1, Roberto Álvarez-Martínez2

1Unit for Basic and Applied Microbiology, Autonomous University of Queretaro, Queretaro, Mexico, 2Universidad Autonoma de Queretaro, QUERETARO, Mexico

The bacteriome is related to the occurrence of cancer in humans, but we know little about its relevance in wild populations, mostly because the incidence of cancer in wildlife is low. An exception is urogenital carcinoma of California sea lions, related to infection by a potentially oncogenic virus, OtHV-1, and common in adult sea lions. Here, we explored the relationship of the abundance and diversity of the cervical bacteriome for inflammation and cellular transformation of adult female sea lions from the Gulf of California. We collected cervical samples from 33 individuals captured at four ecological regions within the Gulf of California and used Miseq Illumina V3-V4 16SrDNA sequencing, as well as PCR to identify the presence of the potentially oncogenic virus, OtHV-1. Using the Bethesda classification on cervical smears, we identified inflammatory cells and markers of precancerous transformation (koilocytes, binucleated cells, reactive cells and atypical metaplastic cells). We detected 1775 amplicon sequence variants (ASVs) in the genital samples, of which 26 were included in the core cervical bacteriome. Some of the key taxonomic groups of the cervical bacteriome are significantly different in females with chronic inflammation and precancerous transformation than in those with a healthy epithelium. Bacteria belonging to classes Fusobacteriia and Clostridia were more abundant in samples with epithelial inflammation, precancerous cell types, and OtHV-1 infection. Some of these bacteria have pro-oncogenic mechanisms, but their relationship with cancer is likely more complex than direct causality, since they are part of the core
bacteriome, and were found to be key players in the structure of co-occurrence networks. Our study is the first investigation of how the bacteriome is related to epithelial integrity in a wild marine species prone to developing cancer.

**Is bigger better? Implications of size on the resiliency of marine mammals to disturbance**

**Stephanie Adamczak**1, Roxanne Beltran2, Elizabeth McHuron1, Enrico Pirotta1, Cara Gallagher1, Daniel Costa4

1University of California, Santa Cruz, Huntington, New York, 2University of California Santa Cruz, Felton, CA, 3University of Washington, Seattle, Washington, 4University of St Andrews, St Andrews, Scotland, United Kingdom, 5University of Potsdam, Roskilde, Germany, 6Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA

Body size plays a fundamental role in species resilience. Smaller animals have limited energy stores and higher mass-specific metabolic costs compared to larger animals and, as such, operate closer to their maximum physiological capabilities. These limitations can make smaller marine mammals vulnerable to disturbances that reduce prey availability or decrease foraging opportunities, thereby affecting energy allocation to current or future reproductive events. However, smaller species typically have a faster pace of life and higher reproductive rates than their larger counterparts, yielding faster population growth and more rapid recovery following a disturbance. To explore these tradeoffs within a species, we examined (a) whether larger individuals are less sensitive to disturbances in a changing environment and (b) whether populations consisting of larger or smaller individuals recover more rapidly following a disturbance. We quantified the effect of disturbance on lifetime reproductive success (LRS) and population dynamics of harbor porpoises, Phocoena phocoena, the smallest cetacean, using a state-dependent behavioral model implemented via stochastic dynamic programming (SDP). Using the SDP model, we simulated disturbance and tracked changes in optimal behavior for multiple individuals that cascade to population-level responses. We compared the impact of acoustic disturbance, modeled as yearly seismic surveys, on LRS and survival of “typical females” (mean weight of 50 kg) relative to “super females” (60 kg). Results to date indicate that in an undisturbed environment, larger females typically live longer and have greater LRS when compared to smaller females. These results provide preliminary support for hypothesis a, which postulates that larger individuals will have more reproductive opportunities, thereby increasing LRS, even in the face of disturbance. We are currently running models that include disturbance. Our results provide insight into the intersection of scaling, energetics, and conservation using the Population Consequences of Disturbance framework, which is critical for the conservation of marine mammal species.

**Control surface-body size relationships in toothed and baleen whale species**

**Danielle Adams**1, KC Bierlich2, Julian Dale3, David Johnston4, Jeremy Goldbogen5, Ari Friedlaender6, Paolo Segre7, Frank Fish8, Richard Blob9, Samatha Price9

1Clemson University, Clemson, SC, 2Marine Mammal Institute, Oregon State University, 3Duke University Marine Lab, 4Division of Marine Science and Conservation, Nicholas School of the Environment, Duke University Marine Laboratory, Beaufort, North Carolina, 5Stanford University, Pacific Grove, CA, 6University of California Santa Cruz, Santa Cruz, California, 7Stanford University, Chico, California, 8West Chester University, West Chester, PA, 9Clemson University, Clemson, South Carolina

Maneuverability in the marine environment
requires a degree of controlled instability. Cetaceans move by dorso-ventral oscillation of their trunk and caudal flukes and have very stable body designs that allow for efficient, steady swimming. To maneuver for behaviors like prey capture, their control surfaces (i.e. fluke, flipper, dorsal fin) are used to create controlled instability. The morphology of the control surfaces are ecologically important to cetaceans due to their hydrodynamic implications, which could affect the ability to execute different feeding strategies. To gain insight into the evolutionary patterns of morphological disparity in whales that use different feeding strategies, and to help understand the hydrodynamics of feeding, we will be analyzing control surface morphology across the majority of cetacean phylogeny. Our initial investigation focused on the relationship between control surface size, shape, and body size of six cetacean species (three mysticete and three odontocete). We assembled aerial photographs of planform control surfaces of mysticete whales and used MorphoMetriX software to measure the size of the fluke, flipper, and caudal peduncle. We also compiled these control surface metrics for multiple odontocete species from stranding images and data. We regressed these metrics on body length to understand scaling differences between species. Preliminary results indicate that there are differences in the slope and intercept of control surface metrics between species, with some control surface metrics showing isometry. The differences in size and shape of control surfaces among these species indicate that they could be using these surfaces differently to create controlled instability.

A Juvenile Humpback Whale (Megaptera novaeangliae) Produces Song Fragments on a Winter Feeding Ground at the Mouth of the Chesapeake Bay, Virginia

Dana Adcock¹, Jeanne Shearer¹, Heather Foley², Zachary Swaim¹, Andy Read⁴

¹Duke University, Beaufort, NC, ²NOAA

Adult male humpback whales (Megaptera novaeangliae) are well-known for producing songs on low-latitude breeding grounds, but they have also been recorded singing on high-latitude feeding grounds. We documented song fragments for the first time on a mid-latitude winter feeding ground at the mouth of the Chesapeake Bay in Virginia. We deployed 11 digital acoustic tags on whales between 2019 and 2021. A likely juvenile whale tagged in 2020 produced vocalizations that we interpret as song fragments. We used waveform and spectrogram analysis to categorize vocalizations into 13 distinct call types and 30 subtypes. Vocalizations occurred almost continuously for 3.2 hours. During the vocalization period, the whale travelled approximately 10 kilometers, with low levels of fluking noted in the accelerometry record, and did not feed. Common calls included low-frequency grumbles, whistles, squeaks, trills (with and without upsweeps), modulated moans, and pulses. Patterning was evident in sequences of call types. For example, a theme of alternating cries and trills was followed by a sequence of alternating cries, low frequency grumbles, and trills which fade into pulses and then a sequence of squeaks, whistles, and pulses. This entire pattern was then repeated. Some of the call types, such as squeaks, whistles, and cries, were similar to calls recently recorded on Caribbean breeding grounds. During 33 minutes with production of 9 of the 13 call types, the whale positioned itself head down with a pitch angle between -20 and -60 degrees, a common orientation observed in singing adult males on breeding grounds. We were unable to determine the sex of the whale. This vocalization behavior may increase the vulnerability of these whales to collisions with large vessels, which occur frequently in this area, due to the orientation and movement patterns during the song fragments.
A Bioenergetic Model for Sea Otters (Enhydra lutris): Exploring Interactions Between Energy Requirements and Dietary Choices
Julia Adelsheim¹, David Rosen², Andrew W. Trites²
¹University of British Columbia, Marine Mammal Research Unit, Vancouver, BC; ²UBC Marine Mammal Research Unit, Vancouver, British Columbia

The high metabolic rates of sea otters (Enhydra lutris) are thought to be the cause of their disproportionate impact on their environment, particularly their prey base. However, the amount of food sea otters require is not just a function of higher energy expenditures, but also dependent upon the complex relationships between the energy density, digestive value, and foraging costs of obtaining different prey items. Therefore, prey selection by sea otters has critical energetic consequences affecting their overall energy balance, and may contribute to limiting range expansion or population growth of sea otters in certain areas. We constructed a new bioenergetic model to investigate how changes in prey characteristics interact with each other and ultimately affect the energy balance of individual sea otters, while accounting for sex, age, and reproductive status. The model was constructed using published energetic, physiological, and behavioral data and was partly validated by a comprehensive historical dataset of growth and food intake from otters maintained in aquariums. The base model quantifies essential energetic expenditures, including thermoregulation, growth, basal metabolism, and reproduction. A separate model component accounts for energy loss related to digestion, including fecal and urinary energy output and heat increment of feeding. A third component within the model investigates how differences in prey quality (proximate composition) and foraging costs (in energy and time) affect the ability of sea otters to fulfill their energetic requirements. Ultimately, this interactive bioenergetic model will allow researchers to input their own data and investigate how the energetics of specific populations are affected by changes in diet or behavior. Overall, this model helps to increase our understanding of potential energetic limitations placed on sea otters due to their dietary choices, and the ultimate implications that this constraint may have on sea otter population dynamics, range expansion, and conservation.

Carbing Up for the Long Haul: Which Grey Whales are Most At Risk When Prey Becomes Scarce?
Selina Agbayani¹, Andrew W. Trites²
¹University of British Columbia, Vancouver, British Columbia; ²UBC Marine Mammal Research Unit, Vancouver, British Columbia

Eastern North Pacific grey whales (Eschrichtius robustus) rely heavily on energy reserves obtained on their northern feeding grounds to complete their annual 17,000 km round trip between the Arctic and Mexico. Unusual mortality events of grey whales in 1999/2000 and 2019/2020 were attributed to starvation caused by reduced prey availability from climate change or increased competition with other feeding whales. However, testing the prey limitation hypotheses and identifying which segment of the population is most at risk has been hampered by not knowing the minimum thresholds of prey needed for different age classes of grey whales to survive the annual migration. We constructed an age-structured bioenergetics model to determine the energy requirements of each migrating cohort of grey whales and estimated minimum thresholds of daily prey consumption needed during summer to avoid nutritional stress during the migration. Inputs included a comprehensive growth model describing mass-at-age, and refined estimates of energetic expenditure for different activity states based on observed respiration rates at each life stage or reproductive
state. Our results show that non-pregnant adults need about 1,100 kg of prey day⁻¹ during summer. Contrary to expectations that lactation costs exceed pregnancy costs, we found both pregnant and lactating females require similar amounts of food—~1,800 kg of prey day⁻¹—during the short foraging season. The relatively high food requirements for pregnant whales reflect their need to store additional energy while pregnant to nurse a calf (~30 L day⁻¹) for its first 6 months of life during the northward migration. This suggests that mothers, calves, and yearlings are more vulnerable to declines in prey availability than non-pregnant females and adult males. Our results can be further combined with measured densities of benthic prey to assess and anticipate the likelihood of starvation-related mortality events occurring, due to either population or environmental changes.

Rice’s Whales in the Gulf of Mexico: A 15-year Photographic Record and the Construction of the First Photo-ID Catalog
Laura Aichinger Dias¹, Kevin Barry¹, Debra Abercrombie², Ruth Ewing³, Anthony Martinez⁴, Patricia Rosel⁴, Jenny Litz⁵, Lance Garrison⁶, Lynsey Wilcox⁷
¹CIMAS/UM, NOAA/SEFSC, Miami, Florida, ²CIMAS/UM, NOAA/SEFSC, ³NOAA, National Marine Fisheries Service, Miami, FL, ⁴Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL, ⁵NOAA Fisheries, Lafayette, Louisiana, ⁶Marine Mammal and Turtle Division, SEFSC, NOAA Fisheries, Miami, Florida, ⁷Miami, FL, ⁸NOAA Fisheries, Southeast Fisheries Science Center, Lafayette, LA

Between 2004 and 2019, the SEFSC conducted 16 vessel-based surveys in U.S. waters of the Gulf of Mexico (GoMx). A total of 108 confirmed Rice’s whale (Balaenoptera ricei) sightings were recorded, including one in the western GoMx. Photos for a photo-identification catalog were obtained from 75% of the sightings. Matching of individual whales across different sightings was done following standard photo-ID protocols using a two-person independent approach. Attributes of the dorsal fin and body markings (scars and skin conditions) were used as individually identifiable features. A total of 60 whales were included in the catalog; 27 lacked distinctive markings on the dorsal fin and body or the photos were of poor quality and did not allow for identification. The remaining 33 whales were considered unique individuals, of which 26 were re-sighted more than once and seven were seen once. Time between re-sighting of individuals ranged from days to more than 15 years and the dorsal fin attributes and body markings remained stable over time. All sightings except one were recorded in the eastern GoMx and no whales seen in the core habitat were observed elsewhere. Twenty-five whales from the catalog were also remotely biopsied and genetically sexed resulting in 11 males and 14 females. Across the 15-year sightings history, observations of potential mother-calf pairs occurred only five times. Interestingly, only three females were involved in these sightings with two of them being re-sighted twice each and with presumably different calves. This is the first photo-identification catalog of Rice’s whales and an important tool in documenting and understanding the sighting histories, broad-scale movements, and habitat use of this small and isolated population.

Exploitation of Black Sea Cetaceans: A Zooarchaeological Perspective
Magie Aiken¹, Canan Çakırlar², Elena Gladilina³, Sergey Telizhenko⁴, Youri van den Hurk², Luminita Bejenaru⁵, Morten Tange Olsen⁶, Pavel Gol'din⁷
¹University of Copenhagen, Copenhagen, Denmark, ²University of Groningen, Netherlands, ³Ukrainian Scientific Centre of Ecology of the Sea, Odessa, Ukraine, ⁴National Academy of Sciences of Ukraine, Ukraine, ⁵Ioan Cuza University of Iași, Romania, ⁶Københavns Universitet - University of Copenhagen,
Black Sea cetaceans, a group that includes harbour porpoises (*Phocoena phocoena*), common dolphins (*Delphinus delphis*), and bottlenose dolphins (*Tursiops truncatus*), are recognised as separate subspecies of special management and conservation concern with IUCN listings of endangered and threatened. While recent exploitation of these species is relatively well documented, ancient exploitation of cetaceans remains poorly understood. Here we present zooarchaeological evidence of cetacean exploitation in the Black Sea from the Mesolithic (8,000 years ago) to the medieval period (600 years ago). Through the analysis of faunal data from archaeological sites, we compare cetacean exploitation to that of other species throughout this time-period in the Black Sea region. The results suggest a transition from freshwater to marine resources in the Mesolithic and a shift to modern marine foodways after the Roman period. Cetacean exploitation targeting all the three cetacean species is present throughout this time-frame and appears to have been more important than initially presumed, especially during the Chalcolithic and Roman time. Zooarchaeological analysis of cetacean remains provides a time depth for understanding cetacean exploitation not available through historic analysis and allows us a better understanding of human cetacean relationships in the Black Sea region.

**Predicting microplastic bioaccumulation in marine mammal foodwebs: insights from 16 diverse EwE trophic-dynamic ecosystem models**

Juan José Alava1, Karly McMullen2

1*Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, British Columbia, 2Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, British Columbia*

Microplastics (MPs) are anthropogenic pollutants widely disseminated in the global ocean; their effects on marine organisms have been explored, but their bioaccumulation behaviour in top predators is relatively unknown. Aiming to simulate MP accumulation in the biomass of marine mammalian foodwebs from diverse marine ecosystems (e.g., Pacific and Atlantic oceans, Barents Sea, Antarctica), we retrieved existing Ecopath with Ecosim trophic-dynamic ecosystem models (EwE models) and applied the Ecotracer (contaminant tracing) module, whilst including MP global ocean distribution data (sea surface/pelagic) from Litterbase. Projections of MP bioaccumulation reflected outputs of energy transfer and mass balance throughout the foodwebs. The trophic magnification factor (TMF) was calculated as a foodweb biomagnification index using the slope (TMF= 10^b, where b= slope) from the regression of the log-transformed predicted concentrations of MPs versus trophic level (TL). An elimination rate constant (kE) of 0.167/day (i.e. Gastrointestinal tract-retention time ≈ 6 days) was used as a default-value for marine mammals. The predicted MP accumulation (in grams) in cetacean biomass (kg) reached the lowest concentration (3.40 x 10^-10 g/kg) in baleen whales (TL=3.81) from the Eastern Tropical Pacific and a maximum concentration (6.70 x 10^9 g/kg) in Antarctic killer whales (TL=4.5). For pinnipeds, Galapagos sea lions (TL=4.0) exhibited the lowest concentration (0.0004 g/kg), while leopard seals (TL=4.11) accounted for the highest concentrations (7.46 x 10^8 g/kg). North Pacific sea otters (TL=3.55) yielded a predicted concentration of 33.8 g/kg. Statistically significant TMF values ranged from 4.60 (b= 0.6701, p<0.0001) in the Galapagos Islands to 55 (b= 1.7398, p<0.0001) in the Antarctic Peninsula ecosystem. The EwE-modelling shows that marine mammals may well be exposed to low, moderate and/or high levels of MPs though
dietary-trophic transfer from prey, depending on the magnitude of exposure levels distributed in the ocean environment; the results highlight the potential bioaccumulation and toxicity risks for apex predators.

Using a deep neural network to classify echolocation clicks and identify spatio-temporal patterns of Pacific white-sided dolphins
Michaela Alksne¹, Simone Baumann-Pickering², Annebelle Kok³, Kait Frasier⁴, Sean Wiggins⁴
¹Scripps Institution of Oceanography, Santa Cruz, CA, ²Scripps Institution of Oceanography, UCSD, La Jolla, California, ³Scripps Institution of Oceanography, La Jolla, CA, ⁴Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA

Pacific white-sided dolphins (Lagenorhynchus obliquidens) are small delphinids whose distribution spans the northern Pacific Ocean from the Gulf of California to the Sea of Japan. Two genetically distinct stocks overlap along the west coast of North America. However, these stocks are visually indistinguishable and the degree of spatial overlap remains unknown. Here, we use a deep neural network to show that the northern and southern stocks are acoustically distinguishable. Previous studies described two distinct echolocation click types associated with Pacific white-sided dolphins and hypothesized that these click types are stock-specific. Our neural network was trained to classify type A and type B clicks based on spectral and temporal properties as described in previous studies. The neural network enabled us to analyze large volumes of passive acoustic recordings from sites between the Gulf of Alaska and Southern California over several years to look at possible stock-specific click type trends. The latitudinal variability of the two click types indicates that they are indeed stock specific. The type A clicks continue to associate with the northern stock distribution, and the type B clicks with the southern stock distribution. Type B clicks were detected farther north during the period of marine heat waves in the region, indicating that the southern stock may have been following warm water anomalies. This may be an early indicator of future phenological shifts in distribution as the oceans continue to warm. The neural network classification method presented here is a novel technique to study spatio-temporal trends of odontocetes and may be especially useful to study species that are only acoustically distinguishable.

Sex, age, and boldness shape the seasonal foraging habitat selection in southern elephant seals
Hassen Allegue¹, Christophe Guinet², Samantha Patrick³, Mark Hindell⁴, Clive McMahon⁵, Denis Réale⁶
¹Département des Sciences Biologiques, Université du Québec à Montréal, Montreal, ²Centre d’Etudes Biologiques de Chizé (CEBC), Chize, France, ³School of Environmental Sciences, University of Liverpool, Liverpool, United Kingdom, ⁴University of Tasmania, Hobart, Tasmania, ⁵Sydney Institute of Marine Science, Mosman, NSW, Australia, ⁶Université du Québec à Montréal, Montreal, Quebec

Foraging habitat selection is a fundamental behaviour in the life of organisms as it directly links resource acquisition to both survival and reproduction. Differences in habitat selection among individuals may arise from several intrinsic and extrinsic factors, and yet, their interaction has been given little attention in the study of wild populations. Here, we combine sex, age (estimated from body length), and boldness to explain individual differences in the large-scale seasonal foraging habitat selection of southern elephant seals (Mirounga leonina) from the Kerguelen Archipelago. We hypothesize that habitat selection depends on the trade-off between resource acquisition and risk, and that individuals differ in their position along this
trade-off because of differences in reproductive strategies, life stages, and metabolic requirements. Before the post-moult foraging trip, we used an approach test to quantify the boldness of 28 subadult and adult females and 42 subadult males and equipped them with data loggers to track their movements at sea. Subadult males selected neritic and oceanic habitats, whereas females mostly selected less productive oceanic habitats. Males shifted from oceanic to more productive neritic and Antarctic habitats with age, whereas females showed some evidence to increasingly select the highly productive marginal ice habitat with age. Bolder males selected northern warmer waters in winter, while shyer ones selected the Kerguelen plateau and southern colder oceanic waters. Females of different boldness types did not show clear differences in habitat selection, although bolder females might select the Kerguelen plateau in the summer when prey profitability is assumed to be the highest. This study provides new insights on the spatiotemporal foraging ecology of southern elephant seals in relation to personality, but also emphasizes the relevance of combining several intrinsic factors to properly understand among-individual variation in space use essential in wildlife management and conservation.

Evidence of a dietary shift by the Florida manatee (Trichechus manatus latirostris) in the Indian River Lagoon inferred from stomach content analyses

Aarin Conrad Allen¹, Cathy Beck², Danielle C. Sattelberger³, Jeremy Kiszka⁴
¹Florida International University, North Miami, FL, ²United States Geological Survey, Gainesville, FL, ³South Florida Water Management District, West Palm Beach, FL, ⁴Florida International University, North Miami, Florida

The Indian River Lagoon (IRL), east coast of Florida, USA, has experienced major changes due to intense human activities and climate change, but remains a critical habitat for a range of large charismatic species such as the herbivorous Florida manatee (Trichechus manatus latirostris). Beginning in 2011, the IRL experienced several harmful algal blooms resulting in a 95% decline in seagrass cover, which may have had an influence on resource selection by manatees. To determine the impact of this seagrass die-off on the diet of manatees, stomach samples from manatee carcasses were examined through micro-histological analysis. Stomach samples collected between 2013-2015 (post-seagrass die-off, n = 90) were compared to archived stomach samples collected between 1977-1989 (pre-seagrass die-off, n = 103). Stomach samples analyzed between 1977-1989 contained primarily seagrass (61.7%), followed by algae (28.4%) and vascular plants (1.7%). In contrast, stomach samples from the post seagrass die-off primarily contained algae (49.5%), followed by seagrass (34%) and vascular plants (2.7%). Between 1977-1980 and 2013-2015, manatees in the IRL experienced a 44.9% decline in seagrass consumption, and a 74.3% increase in algal consumption. The dietary shift of manatees was significant and not influenced by factors such as sex or age, inferred from body length. Although other environmental factors may have influenced this temporal trend, we suggest that the decline of seagrass in the IRL has caused a significant dietary shift. This change potentially demonstrates the dietary plasticity of manatees in the face of foraging habitat modifications. However, the individual and population-level consequences of this shift are unknown. Future research should investigate the energetic costs of this change in the diet of manatees and how it may affect the fitness and reproductive outputs within this population.

Fine-scale song analysis reveals differences in interpopulation song transmission between revolutionary and evolutionary songs in South Pacific humpback whales.

Jennifer Allen¹, Ellen Garland², Claire
Garrigue, Rebecca Dunlop, Michael Noad
1Griffith University, Moorooka, QLD, Australia, 2University of St. Andrews, United Kingdom, 3UMR ENTROPIE Institute of Research for Development, Noumea, New Caledonia, 4Cetacean Ecology and Acoustics Laboratories group, School of Veterinary Science, University of Queensland, Dunwich, QLD, Australia, 5Cetacean Ecology and Acoustics Laboratories group, School of Veterinary Science, University of Queensland, Gatton, Australia

One of the best models for inter-population cultural transmission outside of humans is the song of male humpback whales (Megaptera novaeangliae) in the South Pacific. Song transmission in this region occurs eastward across populations. An examination of sound ‘unit’ sequences can provide a fine-scale understanding of what specific song features may facilitate transmission across populations and how it occurs on such a large scale. This study quantified fine-scale features in the arrangement of unit patterns for six distinct song types during cultural transmission from east Australia to New Caledonia between 2009 and 2015. This included three ‘revolutionary’ song changes, where the entire pattern was replaced between years, and two ‘evolutionary’ song changes, where the pattern was modified in small progressive increments between years. Three features of each song type were quantified: 1) similarity in the song unit sequences, 2) song complexity, and 3) theme complexity. New Caledonian whales learned the stereotyped unit patterns of specific themes with high fidelity, and the complexity of each song’s overall pattern remained consistent between populations at both the song and theme levels. The only exception to this was one evolutionary song type in which complexity diverged due to one complex theme only present in east Australia. Maintaining fine-scale song patterns with such accuracy suggests close acoustic contact between individuals despite the 1600km distance between their breeding grounds. This further supports the hypothesis that interpopulation song transmission in the South Pacific likely occurs on shared feeding grounds or migration routes. However, evolutionary song changes resulted in more divergence between population song patterns, with more themes unique to a single population than in revolutionary songs. Populations may therefore be incorporating their own changes and embellishments into the song as it evolves. This study provides insight into a model of inter-population cultural transmission in animals.

Field Metabolic Rate Validates Cost of Locomotion Estimates in Bottlenose Dolphins

Austin Allen, Andreas Fahlman, K. Alex Shorter Shorter, Joaquin Gabaldon, Rebecca Rimbach, Herman Pontzer, Ashley Blawas, Nicole West, Andy Read
1Duke University Marine Lab, 2Fundación Oceanográfica de la Comunitat Valenciana, Valencia, Spain, 3University of Michigan, Ann Arbor, MI, 4Department of Mechanical Engineering, University of Michigan, Ann Arbor, Michigan, 5Duke University, 6Dolphin Quest Oahu, Honolulu, Hawaii, 7Duke University, Beaufort, North Carolina

By measuring three-axis acceleration, biologging provides opportunities to assess physiological function and energetics in free-ranging species. Previous work has translated acceleration metrics into estimates of the energetic cost of locomotion (COL) by measuring the rate of oxygen consumption ($\dot{V}O_2$) of animals wearing tags in short experimental trials. To fully incorporate estimates of COL into energy budgets, it is important to validate these measurements over longer time scales. We estimated COL in 6 male common bottlenose dolphins (Tursiops truncatus; age = 10-34 years; mass = 141-247 kg) at Dolphin Quest in Hawaii, USA in 2018-2019. We used three methods to estimate daily field metabolic rate (FMR; kcal/day): respirometry calibrated dynamic body acceleration (DBA); dietary records of ingested...
calories; and doubly-labelled water (DLW). We first calculated FMR by applying a correlation between DBA and $\dot{V}O_2$ to fourteen 24-hour tag records to estimate COL. We combined COL with measurements of respirometry-derived postabsorptive resting metabolic rate (RMR) and heat increment of feeding (HIF) estimated from diet records. In this approach, COL comprised 35-45% of FMR, RMR 28-44%, and HIF 19-27%. We then estimated FMR from two-year records of ingested calories (assuming 90% assimilation efficiency). Finally, we estimated FMR with DLW in four individuals. Mean accelerometry FMR ($n = 6$) was 9,851 kcal (SD = 1,404), mean dietary FMR ($n = 6$) was 9,742 kcal (SD = 1,536), and mean DLW FMR ($n = 4$) was 11,860 kcal (SD = 3,595). DLW estimates displayed greater variation due to small sample size. However, comparing the three approaches suggests that the correlation between DBA and $\dot{V}O_2$ can be used to predict COL at daily time scales. The ability to accurately estimate COL will allow us to use biologging approaches to quantify the energetic costs of disturbance with bottlenose dolphins in the wild.

**Gene expression signatures of the long-term transcriptional response to hypoxia in endothelial cells derived from elephant seals**

Kaitlin Allen¹, Peter Sudmant², Jose Pablo Vazquez-Medina³

¹University of California Berkeley, Oakland, California, ²UC Berkeley, ³University of California, Berkeley, Berkeley, California

Elephant seals experience massive fluctuations in blood oxygen during continuous deep diving. Similar fluctuations characterize human pathologies including myocardial infarction and ischemic stroke, but seals tolerate these repeated hypoxic bouts without injury. The inaccessibility of marine mammals diving at sea restricts real-time assessment of the molecular changes that underlie hypoxia tolerance in these animals. Therefore, we developed a proliferative arterial endothelial cell culture system derived from expelled placentae from elephant seals and humans to assess the molecular response to prolonged hypoxia using transcriptomics. Seal and human endothelial cells are metabolically active, express endothelial markers, and generate oxidants when stimulated with agonists. Seal and human cells exposed to 1% oxygen for up to 6 h demonstrate differential stabilization of HIF-1α; seal cells rapidly increase and maintain high HIF-1α protein levels across 6 h while stabilization in human cells is slower and less sustained. Gene set enrichment analysis of differentially expressed genes in seal and human cells exposed to 1% oxygen for up to 6 h reveals downregulation of IL-10 signaling in human cells at early (< 1 h) timepoints, while seal cells downregulated TNF receptors and TGF-β signaling (SMAD3/SMAD4). At 2 h, seal cells upregulated anti-inflammatory signaling (IL-4 and IL-13). Overall, the most upregulated genes in seal cells at early (< 2 h) timepoints are involved in gluconeogenesis (KLF15), intracellular calcium homeostasis (ATP2B4), and DNA repair (USP45). Unexpectedly, one of the most downregulated genes at 1 h was NQO1, a cytoprotective stress protein. Beyond 2 h at 1% oxygen, seal cells continue to prioritize calcium homeostasis and express markers of autophagy (DDIT4L, HK2), glycogen synthesis (PP1R3C) and mitochondrial protection (HK2). Together, these data suggest that seal endothelial cells mount a rapid, robust cellular response to hypoxia which depends on tight regulation of the inflammatory response and metabolic substrate preference.

**Ch-ch-changes: Dorsal fin mark acquisition rates in a community of bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida, USA**

Jason Allen¹, Aaron Barleycorn¹, Kim Bassos-Hull², Sunnie Brenneman¹, Jonathan Crossman³, Allison Honaker⁴, Shauna McBride-Keber⁵, Katherine McHugh¹, Robin Perrtree⁶, Christina
Variability in individual detectability can bias capture-mark-recapture (CMR) models and negatively impact the accuracy of important demographic parameters. One way common bottlenose dolphin dorsal fin photographic-identification studies reduce heterogeneity bias is by only including marked individuals (moderately or highly distinctive) in analyses, but then adjusting for the proportion of unmarked individuals (marginally or not distinct) in post-hoc calculations. A better understanding of when individuals become marked could help account for heterogeneity and improve model estimates. A multi-decadal, monthly monitoring program in Sarasota Bay, Florida, has enabled researchers to accurately identify individuals regardless of fin distinctiveness due to temporary and researcher-applied markings as well as the long-term known associations of individuals, providing a unique opportunity to assess mark acquisition rates. We examined sighting histories and associated images from 19,745 individual identifications of 183 calves born from 2004 to 2019, following them through the end of 2020 or until their death or disappearance. Research-applied marks given to 56 (31%) of the dolphins were ignored. Sixty-two (34%) became marked: 51 (28%) moderately and 11 (6%) highly distinctive. Fifty-one (28%) became marginally distinctive and 70 (38%) remained not distinct. The timing of mark acquisition was highly variable. The mean number of days to become at least marginally, moderately, or highly distinctive was 721 ± 736, 1,275 ± 1,163, and 1,356 ± 1,270, respectively. In cases where sex was known (66 female, 45 male), males (55.6%) acquired more marks than females (36.4%). Of these, 7 females (11%) and 2 males (4%) acquired marks in their first 365 days. Eighty-three calves became independent from their mothers; 28 (34%) were marked before separation and 20 (24%) after, 5 (6%) of which occurred in the first 365 days. These results can help CMR studies account for changes in individual detectability and provide more accurate demographic parameters.

Human injuries from vessel collisions with whales highlight opportunities for increased public messaging to improve operational safety

Dee Allen, Celeste Fazioli, Allison Henry, Edward Lyman, Simone Panigada

1Marine Mammal Commission, Bethesda, Maryland, 2Goucher College, Baltimore, Maryland, 3Northeast Fisheries Center National Oceanographic Administration, Woods Hole, 4NOAA Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, HI, 5Tethys Research Institute, Milan, Mi

Collisions with wildlife not only impact the animals, but humans as well. In vessel collisions with large whales, signs of injury to the whale are documented in stranding or vessel strike reports. These incident reports sometimes note human injury or death, and/or property damage resulting from collisions, particularly involving small vessels. Previous summaries of vessel collisions with large whales acknowledge human safety concerns during collisions in a particular geographic area (e.g., Alaska; Neilson et al. 2012) or with specific vessel types (e.g., sailing vessels; Ritter, 2012). We conducted a global-scale review and compiled over 60 occurrences of vessel collisions with whales in which human injuries or deaths were reported. Human injuries
included: broken bones/teeth, contusions, head injuries, loss of consciousness, death. In many cases, vessel passengers were thrown into objects or onto the deck upon collision; several incidents were reported involving passengers being thrown overboard upon impact, vessel capsizing, or sinking. In cases where the whale species was known, humpbacks were most often involved; however, reports included sperm, blue, gray, and minke whales. Improvements to vehicle, aircraft, and vessel operations in areas where wildlife occur have long benefited from partnerships between biologists and government transportation safety organizations (e.g., Federal Aviation Administration Wildlife Hazard Mitigation). Examining circumstances of incidents, considering the behavior and spatial-temporal occurrence of species, and modifying vessel operations around whale habits improves safety of operators and passengers through mitigation of collisions and lessens human impacts to whale populations. Tools such as WhaleWatch and Whale Alert app have improved vessel operator awareness with near real-time notifications of whale presence. More outreach should focus on educating mariners on the potential hazard of collisions with whales and safe operations of vessels of all sizes to improve human and animal safety.

Using a Mask R-CNN neural network framework to detect Steller sea lions in autonomous camera images

Alexey Altukhov1, Russel Andrews2, Vladimir Burkanov3, Ivan Usatov4, Thomas Gelatt5
1Marine Mammal Laboratory Alaska Fisheries Science Center/NOAA, 2Marine Ecology and Telemetry Research, Kingston, WA, 3Marine Mammal Laboratory, AFSC, NMFS, NOAA, Seattle, Washington, 4Kamchatka Branch of the Pacific Geographical Institute FEB RAS, P-Kamchatsky, Kamchatka, Russia, 5NOAA Alaska Fisheries Science Center, Marine Mammal Laboratory, Seattle, Washington

Steller sea lions (SSL) inhabit the North Pacific, from northern Japan around the Pacific rim and south to central California. SSLs are listed as ‘Endangered’ through much of this range, and therefore documenting changes to their distribution and numbers is critical to their conservation. However, many of their terrestrial sites are remote and difficult to access regularly. Therefore, we installed more than 80 time-lapse cameras (TLC) on different haulout sites and rookeries in Russia and the Western Aleutian Islands to monitor demography. To expedite the task of detecting individual SSLs in the hundreds of thousands of TLC images produced, we explored the use of a region-based convolutional neural network (RCNN). We chose Mask R-CNN, a deep learning neural network framework that is computationally efficient and quick, and able to separate different classes of objects on an image. The first stage of Mask R-CNN, called a region proposal network (RPN), generates bounding box proposals for the regions where there might be an object within the input image. In the second stage, it predicts the class of the object and generates a pixel mask of the object based on the first stage proposal. Initially, we trained this network with 240 randomly selected TLC images, and even with this relatively small number of images in our training dataset we achieved 90% prediction accuracy. This approach allows us to process an entire image at once and to detect SSL even at a wide range of apparent sizes (due to varying distance from the camera) on the same image. Deploying time-lapse cameras or drones throughout more of the SSL range and applying this method to the problem of SSL image detection should vastly improve the ability to monitor this wide-spread but endangered species.

Understanding the risk of infanticide in Shark Bay bottlenose dolphins (Tursiops aduncus)

Diana Alvarado1, Molly McEntee2, Vivienne Foroughirad3, Alexis Levengood4, Ewa Krzyzszczyk2, Céline Frère5, Janet Mann6
1Marine Mammal Laboratory Alaska Fisheries Science Center/NOAA, 2Marine Ecology and Telemetry Research, Kingston, WA, 3Marine Mammal Laboratory, AFSC, NMFS, NOAA, Seattle, Washington, 4NOAA Alaska Fisheries Science Center, Marine Mammal Laboratory, Seattle, Washington, 5NOAA Alaska Fisheries Science Center, Marine Mammal Laboratory, Seattle, Washington, 6NOAA Alaska Fisheries Science Center, Marine Mammal Laboratory, Seattle, Washington
Infanticide by adult males is a sexually selected trait that can improve male reproductive success by accelerating a female’s return to estrous. However, infanticide is only adaptive for males if the calf is unrelated to the infanticidal male and the male has an increased chance of fathering the female’s next offspring. Infanticide has been documented in several delphinid species, including multiple bottlenose dolphin populations. However, at one of the longest running bottlenose dolphin studies in Shark Bay, Australia where males exhibit allied sexual coercion and aggression, infanticide has never been reported despite 36 years of observation. As this population is bisexually philopatric and residential, the presence of local males who are socially associated with or related to females and their offspring might effectively reduce the risk of infanticide, albeit at some cost of inbreeding. Results show that newborn calves (<3 months old; N= 320 calves) spend time in large groups with relatively lower male inclusion than expected. We explore the effect of female-male association history, maternal kinship, and home range overlap, as well as calf paternity, on the association between adult males and females with young calves in Shark Bay. We hypothesize that local males might serve as buffers against infanticide, directly or indirectly, with females avoiding association with unfamiliar males, but tolerating proximity to local, familiar, related, or paternal males when their calves are young and vulnerable to infanticide. This study demonstrates how female socioecological strategies can work in concert with life history parameters (e.g., polygamous mating, polyestrous cycling, and bisexual philopatry) to effectively counter the threat of male aggression and infanticide.

“Go east young dolphin!” Discovering windward coastal Hawaiian spinner dolphins habitat off the Big Island using combined passive acoustic monitoring (PAM) and visual techniques

Petrisha Alvarez1, Adam Pack2, Marc Lammers3, Patrick Hart4

1University of Hawaii at Hilo, 2University of Hawaii at Hilo, Hilo, Hawaii, 3Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, Hawaii, 4University of Hawaii, Hilo, HI

The Hawaiian spinner dolphin (Stenella longirostris), is known to feed offshore during the nighttime hours and return to bays and shallow coastlines to rest during the daytime hours in areas where it has been studied extensively, primarily along the leeward coastlines throughout the Hawaiian islands. In contrast, little effort has been devoted to studies of spinner dolphins off windward coasts. Here we present the first study of Hawaiian spinner dolphins along the windward coast of Hawaii island, combining both long-term PAM recordings complemented by boat-based surveys. Four bottom-moored soundtrap recorders spread over 10 km off Hilo Bay and 500 m from shore within the 10-fathom contour, recorded 30s/300s from June 16th, 2020 - January 06th, 2021. Within this period, 10 boat-based surveys, conducted bimonthly along the same coastline, obtained individual dorsal fin identification and group size estimates (mean = 53.76 ± 24.3 animals, including 2.47 ± 1.57 calves per group). A dipping hydrophone was used during encounters to record acoustic signals while the spinners remained within 200 m of the vessel. Comparisons of these recordings from verified sightings with recordings from the soundtraps provided positive detections for 37% of recordings with spinners as far as 700 m. Sampling of the soundtrap data from survey days
with confirmed spinner dolphin sightings reveals their diel presence across the coastline, with mostly absence during nighttime hours, except at our northern soundtrap location outside of Onomea Bay where some echolocation clicks indicative of foraging occurred throughout the night. Overall, these findings reveal significant habitat use of spinner dolphins along the windward coast of Hawaii Island. An important implication of these findings is that future abundance estimates of island-situated Hawaiian spinner dolphins based on photo-identification should take into account both leeward and windward coastlines.

Genetic status and structure of the endangered Antillean manatee in Cuba

Anmari Alvarez Aleman¹, Thomas Frazer², Maggie Hunter³, James Powell¹, Eddy Garcia Alfonso⁴, James Austin⁵


There remains a limited amount of demographic and genetic information about the Antillean manatees in coastal waters surrounding Cuba, hindering the development and implementation of conservation management plans. Anecdotal information suggests a substantial population decline. Here we present the first population-level genetic data for manatees with the objective of assessing the extent of genetic diversity and structure across the archipelago. We were able to collect tissue and bone samples from 80 manatees and successfully genotyped a subset at 18 microsatellite markers (N = 49) and 1703 SNPs loci (N=27) and evaluated 60 mitochondrial control region sequences. We found evidence of moderate genetic structure between manatees sampled in the Guantanamo Bay region (southeast) from those in western Cuba. We observed signals of inbreeding in both markers (F_is = 0.12 for microsatellites and 0.1 for SNPs) and relatively low nuclear gene diversity compared to endangered, or demographically challenged populations of other mammals and marine mammals (microsatellite H_e=0.46, SNP H_e=0.29). Mitochondrial diversity was very low, with a single haplotype identified among 58 manatees that is identical to the single haplotype found in Florida manatees (A01). In two samples, two sequences were found, haplotype A03 and a newly described A06. The low mitochondrial diversity is similar to the haplotype variation found in other West Indian populations. To inform historical and contemporary connectivity, ongoing analyses will investigate the Cuba population within the larger context of the Antillean population.

Habitat-Specific Use by Short-Finned Pilot Whales in Macaronesia Revealed Through Satellite-Linked Biologgers

Filipe Alves¹, Mieke Wyen², Rita Ferreira³, Annalisa Sambolino, Anja Badenas⁴, Mafalda Correia⁵, AGATHA GIL⁶, Raul Valente⁷, Anna Mora⁸, Marc Fernandez Morron⁹, Massimiliano Rosso¹², Isabel Sousa-Pinto¹³, Ana Dinis¹⁴

¹MARE - Marine and Environmental Sciences Centre, Portugal, ²Ghent, Belgium, ³MARE-Madeira, Portugal, ⁴MARE, ⁵Marine and Environmental Sciences Centre, Funchal, Portugal, ⁶MARE- Marine and Environmental Sciences Centre, Funchal, Portugal, ⁷UTAD, ⁸UTAD, CIIMAR, CSIC, Porto, Cedofeita, Portugal, ⁹FCUP - Faculty of Sciences, University of Porto, CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, Porto, Portugal, ¹⁰OceanExplorer La Palma, La Palma, Canary Islands, Spain, ¹¹Universidade dos Açores, Ponta delgada, Azores, Portugal, ¹²CIMA Research Foundation, savona, Savona, Italy,
Knowledge of animals' movement patterns is essential to assess their range, habitat use or preferred areas. Nevertheless, obtaining such information at fine-resolution is challenging for free-ranging and deep-diving cetaceans. Previous studies demonstrated that the Macaronesian (NE Atlantic) short-finned pilot whales (*Globicephala macrorhynchus*) have complex intra- and inter-archipelago movements. Nonetheless, there is no information on the species regarding their fine-scale habitat preferences and movement drivers. To that, satellite (SPOT6) biologgers were deployed in robust adult/subadult animals of both sexes in Madeira Island year-round during 2018-2021. A total of 2688 tracking locations from seven animals were processed using the Kalman filter. These comprised 388 days, and durations ranged between 13-150 days. The individuals spend 53% of the time between 3-20km off the coasts of Madeira Archipelago, particularly in a small area at the SE of Madeira Island (ca. 400km², used by all tagged animals). Two individuals travelled between archipelagos (Madeira-Canaries), representing only 9% of the total time. The remaining time was spent off the Canaries' western islands (La Palma, El Hierro), with regular movements to SW offshore waters (likely associated with warmer SST areas). Tracking data was complemented with photographic-identification catalogues from Madeira and La Palma. Twelve animals (7% of the La Palma catalogue) were matched for both locations, supporting the potential existence of a biological corridor linking these populations. Based on preliminary results of a work in progress, this study supports that individual pilot whales in Macaronesia are associated with specific islands and hotspots for foraging, resting, or socializing.

A tidal powered marine renewable energy application for marine mammal observation in active maritime areas

Alicia Amerson¹, Joseph Haxel¹
¹Pacific Northwest National Laboratory, Sequim, WA, ²PNNL, Sequim, Washington

Marine renewable energy technology can extend the endurance of hydrophone systems used to detect the acoustic presence of whales in real-time, measure ambient noise levels, and provide data that informs the maritime transit industry in Puget Sound. This innovative technological research is conducted at the Pacific Northwest National Laboratory where we are designing a portable, passive acoustic monitoring (PAM) system powered by a small current energy converter to be deployed as a large-scale array in areas near transit routes susceptible to marine mammal encounters in Puget Sound. The array of tidal-powered hydrophones will be spatially dispersed along the ferry routes in the Sound with data telemetered to shore through a cellular link, potentially providing mariners with near real-time information on the presence of vocalizing whales in navigation corridors. Marine renewable energy provides a unique opportunity for longer deployments with sufficient energy for onboard processing, data telemetry, and real-time marine mammal detection. We demonstrate how marine renewable energy-powered acoustic systems that are portable and low-cost may provide a safe and environmentally conscious observatory alternative in important marine mammal habitats that are challenged with elevated anthropogenically influenced acoustic conditions, and possibilities for ship strikes.

At-sea movements and haul-out behavior of tagged harbor seals (Phoca vitulina vitulina) in their newly expanded range off the eastern United States

Kristen Ampela¹, Rob DiGiovanni², Monica DeAngelis¹, Jacqueline Bort¹, Deanna Rees²
Andrew DiMatteo1, Alexandra Wilke7
1HDR, Inc., San Diego, California, 2Atlantic Marine Conservation Society, 3NUWC-Naval Undersea Warfare Center, Portsmouth, RI, 4U.S. Naval Facilities Engineering Command, Atlantic, Norfolk, VA, 5NAVFAC Atlantic, Norfolk, VA, 6CheloniData LLC, Berthoud, CO, 7The Nature Conservancy, Virginia Coast Reserve, Nassawadox, VA

In the last few decades, harbor seals (Phoca vitulina vitulina) have expanded their range southward along the U.S. East Coast. Their habitat use, dive, and haul-out behavior in this newly expanded range are largely unknown, as is the degree of potential overlap between seals and sources of anthropogenic disturbance, in particular U.S. Navy military readiness activities. To better understand these factors, we tagged nine harbor seals (seven in February 2018, and two in February/March 2020) in coastal Virginia, a busy hub of naval activity. We deployed a total of six location-only SPOT tags and three depth-sensing SPLASH tags (two of which were GPS-enabled, providing location accuracy of up to 20 m). Tag data included: time spent hauled out vs. in-water, ambient water temperatures, short-(n=9) and long-distance movement patterns (n=8); and dive profiles (n=3). Haul-out behavior (Virginia waters only) was also examined with respect to tidal cycle, air and water temperature, time of day, and wind speed. Tagged seals spent a cumulative 450 days in Virginia waters, and on 83 of these days (19%) satellite tags reported locations within the Navy’s VACAPES operating area. While in Virginia waters, the mean dive depth recorded by the three SPLASH tags was shallower than 10 m. Dive depths generally increased when the seals migrated north in the March/April timeframe. All nine seals tagged in this study were as likely to haul out on a high tide as on a low tide, and were more likely to haul out when wind speed was less than 15 knots. The results from this study provide new information about harbor seal movements in the southern extent of their current range in U.S. waters, as well as valuable baseline data needed to assess potential impacts to seals from Navy activities in Virginia waters and along the Eastern Seaboard.

Growth and Acoustic Development of Harbour Porpoises (Phocoena phocoena) Age 1-2 Years
Kirstin Anderson Hansen1, Emilie Nicoline Stepien3, Héloïse Hamel3, Ursula Siebert4, Magnus Wahlberg5
1Marine Biological Research Center, University of Southern Denmark; Fjord&Bælt, Kerteminde, Denmark, 2Section for Marine Mammal Research, Bioscience, Aarhus University, Denmark, Roskilde, Denmark, 3Marine Biological Research Centre, University of Southern Denmark, 4Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Buesum, Schleswig-Holstein, Germany, 5Marine Biological Research Centre, University of Southern Denmark, Kerteminde, Funen, Denmark

Measuring growth and blubber thickness in harbour porpoises (Phocoena phocoena) of known age are important tools to monitor the size, age distribution and health of wild porpoise populations. Likewise, investigating the development of clicking sounds in young individuals may contribute to our possibilities to differentiate age classes in passive acoustic monitoring projects. Here, we use photogrammetry to do monthly measurements of the growth of two young porpoises housed at a Danish facility during an age of 1 to 2 years. The measurements were calibrated through the same photogrammetry methods used on a 26-year-old female housed at the facility, for which a detailed track record exists on body measurements. The clicking sounds of the porpoises were monitored every month, along with their frequency content, duration and inter-click intervals, and were compared with the 26-year-old female. We
outline how the detailed data on growth and click development from these animals can be used in improved passive acoustic monitoring efforts, as well as visual population assessments of wild populations using drones.

**Skin lesions on common bottlenose dolphins in the Gulf of Ambracia, Greece.**

Carmen Andrés¹, Joan Gonzalvo²
¹Tethys Research Institute, Barcelona, Spain,
²Tethys Research Institute, Milano, Milano, Italy

The common bottlenose dolphin (*Tursiops truncatus*) is the only cetacean species present in the semi-enclosed Gulf of Ambracia, in Western Greece. Despite this being an increasingly degraded coastal ecosystem, dolphins are found at one of the highest reported densities for this species in the Mediterranean. Cutaneous diseases are continuously reported in many cetacean species worldwide and Ambracian dolphins are no exception. The prevalence of skin conditions in this dolphin population was previously studied using photo-id data from years 2011 and 2012, reporting evidence of epidermal lesions in 37% of a total of 153 dolphins. Using the same methodology and concentrating efforts in 2019 and 2020 photo-id data, six different skin lesions were considered, namely dark-fringed spots, white-fringed spots, orange patch, tattoo-like, white fin-fringe and white-dots. Our results revealed that 50% of a total of 117 dolphins evaluated showed some skin lesion. Of those, more than half (57%) manifested white-dots (WD), resulting in the most frequent skin condition with different degrees of severity. From 34 animals with WD, 16 already had it during the 2011-2012 evaluation, while the remaining 18 developed it over the last 8 years. When looking at the severity of their WD, by examining all historical records for each dolphin in our photo-Id catalogue, 26 manifested mild, 3 moderate and 5 severe conditions. A severe condition was characterized by dots densely widespread across the body giving to the dolphin a strikingly whitish appearance. All affected individuals either worsened or maintained a stable WD condition throughout the years. Although the etiology of these skin disorders could not be assessed yet, they may be consequence of dolphin exposure to high levels of pollution, mostly derived from local agriculture (i.e., pesticides). Future investigations on the health status of this dolphin population (e.g., toxicological analysis) should shed light on this issue.

**Protection and valuation of whales and dolphins by the local community in the municipalities of Anakao, Soalara Sud and Saint Augustin, ToiliaraII, south-west of Madagascar.**

Norbert Andrianarivelo¹, Salvatore Cerchio²
¹Institut Halieutique et des Sciences Marines, Université de Tolara, Madagascar, Taolagnaro, Fort, Madagascar, ²African Aquatic Conservation Fund, East Sandwich, Massachusetts

For decades, the communities of fishers of the three municipalities of Anakao, SoalaraSud and Saint Augustin in the south-western region of Madagascar were hunters of cetaceans. Socio-ecological interviews indicated that thousands of cetaceans were caught there for local consumption and sale between 1970 and 2000. In 2008, the Fikambanana Miaro nyTrozona sy Fesotra (F.M.T.F), or Association for the Protection of Whales and Dolphins, was created after a series of workshops on the conservation of marine mammals that we carried out jointly with the Madagascar National Parks. The goal of this association is to protect and to increase the value of marine mammals through community-based whale watching and the application of the local laws. Since 2010, the hunters of the cetaceans have been trained to become tourist guides and take whale and dolphin watchers on the water using traditional and motorized dugout canoes. As a result, the number of guides rose from 6 in
2010 to 42 in 2019, and the number of whale watching tourists from 143 in 2010 to 1587 in 2019. The price varies from 40000 Ariary (11,76 Euros) to 60000 Ariary (17,65 Euros) per tourist according to the location and the duration of the excursion. All local laws related to hunting and codes of good conduct for whale watching are written in the local convention or Dina which is strongly respected by the local communities. Recognizing the advantages of these activities, the local communities which previously were cetacean hunters, are now becoming strictly protectors of cetaceans.

**Higher levels of emerging and legacy contaminants in odontocete than baleen whales from Norway**

Clare Andvik¹, Eve Jourdain², Jan Ludwig Lyche³, Ellen Katrin Enge⁴, Mikael Harju⁵, Tore Haug⁶, Richard Karoliussen⁷, Katrine Borgå⁸

¹University of Oslo, LOMMEDALEN, Bærum, Norway, ²Norwegian Orca Survey, Andenes, Norway, ³Norwegian University of Life Sciences, Oslo, Norway, ⁴Norwegian Institute for Air Research, Kjeller, Norway, ⁵Norwegian Institute for Air Research, Tromsø, Norway, ⁶Marine Mammals Division, Institute of Marine Research, Tromsø, Norway, ⁷Norwegian Orca Survey, Andenes, Norway, ⁸University of Oslo, Oslo, Norway

Marine mammals are considered sentinel species for marine ecosystem health due to the bioaccumulation of legacy and emerging contaminants in their tissues. Data on the presence and levels of many contaminants, however, remain missing or incomplete for many whale species from Norway. The aim of this study was to conduct the first thorough screening of legacy and emerging contaminants in marine mammals from Norway, and investigate inter-species differences. We collected samples from 34 individuals of nine different species that stranded along the Norwegian coast 2015–2020, including one neonate killer whale (*Orcinus orca*) of approximately 10 days of age. In addition, samples from 14 adult minke whales (*Balaenoptera acutorostrata*) and nine fetuses were obtained from the 2019 harvest in the Barents Sea. Legacy and emerging contaminants were quantified, including polychlorinated biphenyls (PCBs), brominated flame retardants and per- and polyfluoroalkyl substances (PFAS). The stable isotope ratios of carbon and nitrogen (δ¹³C and δ¹⁵N, respectively) were additionally quantified as dietary indicators. Higher contaminant levels were found in the toothed whales in comparison to the baleen whales, which also had higher δ¹⁵N values in skin and muscle, that confirm feeding from higher trophic levels. ΣPCB levels in blubber exceeded the threshold for a risk of health effects (9 µg/g lw) in 7 of the 8 killer whales, including the neonate, and 3 of the 7 sperm whales (*Physeter macrocephalus*). We found PFAS in the killer whale calf and the minke whale fetuses, confirming maternal transfer, and higher PFAS levels in minke whale fetuses than toothed whales indicating efficient placental transfer. Our results are relevant for an understanding of the prevalence and persistence of these contaminants in the Arctic to aid in possible future regulation.

**Differences in the whistle repertoire of two common bottlenose dolphin (Tursiops truncatus) ecotypes in the Gulf of California**

Simone Antichi¹, Maia Austin², Laura J. May-Collado³, Jorge Urban⁴, Eduardo Romero-Vivas⁵, Lorena Viloria Gomora⁶

¹Universidad Autonoma de Baja California Sur, La Paz, Baja California Sur, Mexico, ²University of Vermont, Burlington, VT, ³Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico, ⁴CIBNOR, La Paz, Mexico

Sounds produced by cetacean species show differences among populations, geographic distributions, individuals, and ecotypes. Coastal and oceanic ecotypes of common bottlenose
dolphin (*Tursiops truncatus*) have been reported in many regions, including the Gulf of California, Mexico. Whistles of both ecotypes were recorded in La Paz bay, assessing possible differences. Data were collected between October 2020 and September 2021, using a Marantz PMD661 recorder (96 kHz sampling frequency) and a Reson TC4013.1 hydrophone (Sensitivity - 211dB ±3dB re 1V/µPa, Frequency response 1Hz to 170 kHz, Omnidirectional). Audio files were analyzed in the time-frequency domain (1,024 point FFT, Hann window, 50% overlap) using Luscinia software (version 2.16.10.29.01). Only whistles clearly visible in the spectrogram were considered for analysis. Standard parameters, namely: minimum frequency, maximum frequency, frequency range, starting frequency, ending frequency, peak frequency and duration were measured for both ecotypes. Dynamic time warping was used to compare the whistle contour repertoire between the two ecotypes. The results show that ecotypes produce similar whistle repertoires but at different frequencies. Oceanic dolphins produce whistles at higher frequencies than their coastal counterparts. Differences in whistle frequency between ecotypes could result from differences in group size and acoustic characteristics of their habitat.

Cetaceans are efficient swimmers, with estimated propulsive efficiencies exceeding those of mechanical propellers. However, experiments to verify these efficiencies have been limited because swimming kinematics and kinetics are difficult to measure due to the inherent challenges of the marine environment. Biologging tags are used to measure kinematic data from a single location on the animal, but information about whole-body kinematics and kinetics is limited. To address this issue, we present an approach to estimate sagittal-plane, whole-body kinematics of a bottlenose dolphin (*Tursiops truncatus*) from tag data using machine learning techniques. We segment the dolphin body according to a sagittal-plane hydromechanical model of bottlenose dolphin swimming, with a head, torso, and two caudal peduncle segments, to which a flexible, semilunate fluke is attached. The goal is to map the kinematics of the torso segment that can be measured using biologging tags containing an inertial measurement unit to the joint angles of the model. A Temporal Convolutional Network (TCN) was chosen for its ability to take into account temporal information to make its predictions. To train the TCN, we used synthetic data from the hydromechanical model. Our results show that the TCN was able to learn the mapping from the torso attitude to whole-body dynamics during steady-state swimming. We apply this method to kinematic data collected from a tag placed anterior to the dorsal fin of a bottlenose dolphin at Dolphin Quest Oahu. The estimated whole-body kinematics, along with center-of-mass-corrected tag data, are subsequently used to drive the hydromechanical model and estimate hydrodynamic forces at the fluke, the resulting thrust power, and the propulsive efficiency. This approach enables the estimation of swimming kinematics and kinetics for dolphins in both managed and wild settings, greatly expanding our ability to investigate dolphin swimming biomechanics using biologging tags.
Trophic Reconstruction in Northern Sea Otters (Enhydra lutris kenyoni): Indicator of Regional Population Fluctuations?

Taylor Apter¹, Amy C. Hirons², Verena Gill³, Lori Polasek⁴

¹Nova Southeastern University, ²Nova Southeastern University, Dania Beach, FL, ³NOAA Fisheries, Anchorage, Alaska, ⁴Alaska Department of Fish and Game, Junea, Alaska

The northern sea otter (Enhydra lutris kenyoni) inhabits the temperate coastal waters of southern Alaska from the Aleutian Islands eastward to Southeast Alaska. Three stocks of northern sea otters are recognized within Alaska: southeastern, southcentral, and southwestern. The southwestern Alaskan population stock has declined drastically in the past decades and has been listed as threatened under the Endangered Species Act (ESA) as of August 2005. Stable isotope analysis using sea otter vibrissae will provide invaluable temporal and spatial information on this endangered population’s trophic dynamics. Each vibrissa provides approximately one year of trophic data in the continuously growing tissue. This study is conducting a trophic reconstruction and regional comparison of approximately 160 individual sea otters from the southwestern, southcentral, and southeastern population stocks collected between 1994-2014 using stable carbon and nitrogen isotope ratios. Preliminary data of approximately 50 individuals show that location is a significant factor differentiating trophic ecology between the southcentral and southwestern sea otter populations (ANOVA: df = 3, F = 4.9037, p = 0.0065; df = 3, F = 11.947, p < 0.0001). The δ¹³C and δ¹⁵N values significantly varied between the Prince William Sound, the Aleutian Archipelago, and the Alaskan Peninsula (p<0.01). The southwest population has shown a greater enrichment in δ¹⁵N than the southcentral population, indicating a differentiation in trophic ecology. There has been no significant variation in δ¹³C and δ¹⁵N within these sea otter populations, suggesting common trophic position within these regions. Continued research and analysis will allow us to identify potential trophic shifts among the three stocks and any trends during the past 2 decades.

Haiti Ocean Project: Marine mammal intervention, outreach, and conservation programs in the Nippes Region of Haiti

Jamie Aquino¹, Shane Gero², Courtney Vail¹, Mike Walsh¹, Cleeford Joseph¹, Francklin Barbier¹, Charless Calixte¹

¹Haiti Ocean Project, West Palm Beach, Florida, ²Aarhus University, Aarhus, Aarhus C, Denmark, ³Haiti Ocean Project; Lightkeepers Foundation, Phoenix, Arizona, ⁴University of Florida, Gainesville, FL, ⁵Haiti Ocean Project, Petite Riviere de Nippes, Haiti

In February 2009, a unique partnership between educators, field researchers and organizations in the United States, Dominican Republic and Haiti was launched with a goal towards developing a pilot project to raise awareness and promote the protection of marine mammals in Haiti. After more than a decade of collaborative field initiatives and the establishment of a permanent research site in Petite Riviere de Nippes, Haiti, the Haiti Ocean Project (HOP) has documented at least 13 marine mammal species, including dwarf sperm whales, short-finned pilot whales, beaked whales, pantropical spotted and bottlenose dolphins, manatees, and sperm and humpback whales in Haitian waters. Of these species, 3 are seen at least 6 months of the year and another 4 species are seen at least 3 months of the year. The proximity of pelagic species is likely enhanced by deep water canyons close to shore. The mission of HOP is to protect Haiti’s marine life through community outreach, advocacy, and science. HOP also works to facilitate cooperation and support for Haitian environment ministries and marine protected areas; conduct educational outreach to students and local communities; organize capacity
building and training for networks of local fisherman; and evaluate the potential for local ecotourism involving whale and dolphin watching. The identification, categorization, and documentation of marine mammal populations is a first step towards promoting the long-term protection of Haiti’s marine resources. The Project has documented 14 incidents of marine mammal directed and opportunistic take and entanglement in fishing gear—primary threats to marine mammal populations in Haiti. Ongoing collaboration with local fishing communities provides significant opportunity for intervention in the directed take of marine mammals, heightened awareness, and the exploration of alternative livelihoods. A more rigorous scientific research program is needed to complement community outreach and traditional knowledge integral to HOP’s grassroots approach.

Guarujá city’s (São Paulo - Brazil) contribution to the preservation of marine mammals in UNESCO Decade of the Oceans.

Sidnei Aranha¹, Claudia Carvalho do Nascimento², CLAUDIO Souza Vieira Junior³, Marina Zabini³, Ricardo de Sousa³, Cleiton Santos Jordão³, Bruna Ramos Garcia³, Thais Juliane Rodrigues dos Anjos Diniz⁴

¹Department of Environment of the City of Guarujá, GUARUJA, São Paulo, Brazil, ²Mineral Engenharia e Meio Ambiente, Brazil, ³Mineral Engenharia e Meio Ambiente, São Paulo, São Paulo, Brazil, ⁴Environment Secretariat of the City of Guarujá, Guarujá, São Paulo, Brazil

The city of Guarujá, located in the central coastal part of the state of São Paulo in southeastern Brazil, has frequently recorded, through the Santos Basin Beach Monitoring Project (PMP-BS), the occurrence of marine mammals. Between 2015 and 2020 (data available in (www.simba.petrobras.com.br) 234 marine mammals were recorded in this region, being 01 Delphinus delphis, 03 Megaptera novaeangliae, 189 Pontoporia blaivillei, 11 Sotalia guianensis, 01 Stenella frontalis, 05 Tursiops truncatus and 19 unidentified marine mammals. Of these recorded species, 85.47% are considered endangered. Having this relevant information the municipality of Guarujá has been developing numerous environmental actions in order to promote sustainable management, such as treatment actions and disposal of waste and urban effluents that can reach the sea and research on the occurrence of micro plastic on the city's beaches. Through participatory management with civil society, the city carried out the implementation of the Serra do Guararú Environmental Protection Area, awarded by IUCN and ICLEI, as an important area for marine and land preservation, contributing to achieving several UN Sustainable Development Goals and the Aichi Biodiversity Targets. Considering the high occurrence of marine mammals threatened with extinction in Guarujá, these actions reflect the city's commitment to contributing to the actions for the UNESCO Decade of Oceans, with proactive actions to maintain a healthy ocean for the preservation of marine mammals.

The eastern Pacific long-beaked common dolphin (Delphinus bairdii): Taxonomic status and re-description

Thomas Jefferson¹, Frederick (Eric) Archer², Kelly Robertson¹

¹Clymene Enterprises, Lakeside, California, ²Southwest Fisheries Science Center, La Jolla, California, ³Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanographic and Atmospheric Administration, La Jolla

In the past, neritic, long-beaked common dolphins have been described as species distinct from the more oceanic and globally distributed short-beaked species, Delphinus delphis,
although recent molecular studies have challenged this view. In the eastern North Pacific (ENP), the taxonomic status of the long-beaked form has been controversial since its original description in 1873, and has vacillated back and forth between species, subspecies, and geographic form several times. It is currently provisionally viewed as a subspecies of *D. delphis* (*D. delphis bairdii*), though this is controversial. To clarify the situation, we reviewed relevant literature and conducted additional analyses using extensive molecular genetic and cranial morphometric datasets. The results indicate that there are diagnostic differences in skull morphology and genetics between the ENP long-and short-beaked forms. Further we found that, despite a large distributional hiatus, the long-beaked population off Peru (South Pacific) clusters with the ENP long-beaked form. These differences, along with indications of ecological distinctions, including important differences in life history parameters and reproductive timing, strongly suggest that the long- and short-beaked forms are on divergent evolutionary pathways. As such, we consider them to be distinct, though closely related, species in the eastern Pacific. The long-beaked species is referable to *Delphinus bairdii* Dall, 1873, and is hereby re-described as such.

**Factors Influencing the Prevalence of Human-Interaction Behaviors of Common Bottlenose Dolphins *Tursiops truncatus***

**Cristin Alexi Archer¹**, Robin Perrtree², Tara Cox²

¹Savannah State University, Plymouth, MA, ²Savannah State University, Savannah, Georgia

Wildlife managers have implemented education and management strategies in an attempt to decrease both the reliance of wildlife on humans as a source of food and the interactions between humans and wildlife. Researchers have recorded the common bottlenose dolphin *Tursiops truncatus* engaging in human-interaction behaviors (HIB) to gain access to food in various locations globally. Savannah, Georgia, USA has the highest rates of HIB in the world, and since 2010, managers and researchers have engaged in enforcement and education to decrease HIB prevalence. We collected data using photo-identification during boat-based surveys from 2009 to 2018 and evaluated our 10-year data set to understand how factors, such as group size, season, and number of individual begging dolphins, correlated to HIB prevalence. HIB prevalence decreased from 23% to 8% of sightings and 56% to 30% of days from 2009 to 2018. The number of individual begging dolphins decreased from 43 begging dolphins in 2009 to 19 begging dolphins in 2016. Group sizes with begging decreased from 9.0±7.0 dolphins in 2009 to 5.8±4.7 dolphins in 2018. Group sizes when there was no begging stayed constant from 4.2±3.3 dolphins in 2009 to 4.6±5.3 dolphins in 2018. The percentage of begging sightings during the summer (May-Sept) decreased from 22% in 2009 to 6% in 2018, and during the winter (Nov-Mar) decreased from 16% in 2010/2011 to 6% in 2017/2018. As HIB prevalence decreased, so did factors such as number of individual begging dolphins, begging group size, and begging sightings during summer and winter. There appears to be a correlation between enforcement and education efforts and the decrease in HIB prevalence. Future education efforts should continue to focus on educating the public on the detrimental impact of feeding dolphins. Understanding factors influencing HIB behaviors in wildlife populations can assist managers in implementing targeted education efforts.

**Pinnipeds as sentinels of antimicrobial resistance: Spatial analysis of antimicrobial resistance genes from gray seal fecal samples in UK waters***

**Lauren Arkoosh¹**, Scott Cameron², Kimberley Bennett³, Debbie JF Russell⁴

¹Abertay University, St Andrews UK, United
Antimicrobial Resistance (AMR) is a pressing concern to human and animal health. Bacteria harboring antimicrobial resistance genes (AMRG) are present in the environment, and can spread rapidly in human and industrial waste, agriculture, and aquaculture. Many of the waste products from these processes eventually make their way to river and ocean waters, providing bacteria carrying AMRG ample opportunity to disseminate. Pinnipeds are apex predators in UK waters, sampling the entirety of the water column when they forage. These animals regularly return to haul out on shore which makes their fecal matter accessible and provides a way to examine AMR in the food web and the wider environment. Previous studies have examined a limited and biased number of known pathogens for AMRG in marine mammals, resulting in a limited understanding of which specific AMRGs are present and prevalent in the marine environment. AMRG have the capacity to be transferred between bacteria, allowing genes that are not currently found in pathogenic bacteria to be identified and used as an early warning of the potential for transfer to pathogens of clinical and zoonotic concern. This study developed a novel medium-throughput PCR-based screen for the presence/absence of 90 AMRG across most antimicrobial classes of clinical and environmental importance. This screen was used to analyze AMRG in fecal matter from 101 seals from UK populations for which telemetry data were also available. Here we present the spatial analysis of the seal gut resistome, showing how AMRG diversity differs between regions and between animals of different sexes. Next steps will involve a more detailed exploration of links between AMRG and habitat selection. Analysis of the pinniped gut resistome allows for assessment of the impact of changes in AMRG prevalence while creating a baseline for UK waters.

Support for the life-history-oxidative stress theory from an animal model of simultaneous lactation and fasting: blubber oxidative stress impacts lactation strategy and pup weaning mass in grey seals (Halichoerus grypus)

Holly Armstrong1, Simon Moss2, Debbie JF Russell3, Paddy Pomeroy4, Kimberley Bennett5
1University of St Andrews, United Kingdom, 2Sea Mammal Research Unit, St. Andrews, United Kingdom, 3SEA MAMMAL RESEARCH UNIT, UNIVERSITY OF ST ANDREWS, ST ANDREWS, United Kingdom, 4Sea Mammal Research Unit, St Andrews, United Kingdom, 5Abertay University, Dundee, United Kingdom

Life-history-oxidative-stress theory predicts that elevated costs during reproduction reduce allocation to defences and increase oxidative stress, with fitness consequences, particularly when resources are limited. As capital breeders, grey seals provide an extreme natural system in which to test this theory. Investment in cellular defences and levels of oxidative stress in blubber of wild, female grey seals were investigated during their lactation fast ($n = 17$) and contrasted with their foraging period ($n = 13$). We measured blubber mRNA abundance of heat shock proteins ($Hsp$s) and redox enzymes ($RE$s), and malondialdehyde (MDA) concentration, an index of lipid peroxidation, to investigate tissue-level impacts of altered cellular defences. We examined associations between blubber cellular defences or oxidative stress and body mass, a proxy for intrinsic resources, and maternal performance, a measure of fitness. Body mass was negatively related to $Hsp70$ and $Hsp27$ abundance during their lactation fast ($n = 17$) and contrasted with their foraging period ($n = 13$). We measured blubber mRNA abundance of heat shock proteins ($Hsp$s) and redox enzymes ($RE$s), and malondialdehyde (MDA) concentration, an index of lipid peroxidation, to investigate tissue-level impacts of altered cellular defences. We examined associations between blubber cellular defences or oxidative stress and body mass, a proxy for intrinsic resources, and maternal performance, a measure of fitness. Body mass was negatively related to $Hsp70$ and $Hsp27$ abundance at early lactation suggesting heavier mothers experience lower cellular stress. Abundance of these $Hsp$s and $Nox4$, a pro-oxidant enzyme, decreased throughout lactation. Higher mRNA abundance of some $Hsp$s, and lower $RE$ mRNA abundance and MDA
concentrations in foraging females suggests they experience lower oxidative stress. Nox4 abundance and oxidative damage in blubber were associated with reduced lactation duration and higher maternal mass loss rate, which were positively related to pup weaning mass. These findings suggest oxidative stress can proscribe the lactation strategy adopted by grey seal mothers, and may affect pup survival probability. Fat accumulation prior to breeding does not insure against reduced investment in cellular defences or increased oxidative stress during lactation. These data thus support the life-history-oxidative-stress hypothesis in a capital-breeding mammal, and suggest that lactation is a period of heightened vulnerability to additional stressors. Oxidative stress constraints on life history decisions are of particular concern for individuals and wildlife populations exposed to additional natural or anthropogenic stressors.

Louder petrol engine noise disrupts whale resting and nursing
Patricia Arranz¹, Maria Glarou¹, Kate Sprogis³
¹University of La Laguna, La Restinga, Santa Cruz de Tenerife, Spain, ²University of Iceland, Husavik Research Centre, Husavik, Iceland, ³Marine Bioacoustics Lab, Aarhus University, Australia

Vessel noise drives behavioural disturbance in cetaceans targeted during whale-watch activities. Despite the growing effort for implementing best-practice principles, currently there are no regulations on whale-watch vessel noise levels. We test the hypothesis that a whale-watch vessel with low noise emission engines will not elicit short-term behavioural responses in toothed whales compared to the same vessel with louder engines. We measured the behavioural responses of 36 resting mother and calves short-finned pilot whales (Globicephala macrorhynchus) to whale-watch vessel approaches (range 60 m, speed 1.5 knts). Treatment approaches with quieter electric engines (140-136 dB) compared to the same vessel operating with louder petrol (151-139 dB) engines (low-frequency – mid-frequency weighted source levels, re 1 µPa RMS@1m) were examined. During petrol engine treatments, the mother’s resting time significantly decreased by 29 % compared to the control. The proportion of time nursing for the calf was significantly influenced by petrol engine vessel passes, with an 81 % decrease compared to the control. There were no significant effects on behaviour from the quieter electric engine. These results are consistent with behavioural changes in response to vessel noise leading to an increase of energy consumption by mothers and to a reduction in the energy gain by the calves. Moreover, these results demonstrate that different vessel noise levels can elicit different behavioural responses on cetaceans, even if operators comply with the current, national whale-watching guidelines. Thus, to minimise disturbance on the activity budget of pilot whales, the establishment of source level criteria of whale-watch vessels is recommended. Whale-watch vessels would ideally have source levels as low as possible, <150 dB re 1 µPa RMS@1m and perceived slightly above ambient noise. Lower vessel engine noise will benefit tourists seeking an eco-viewing opportunity, whilst reducing disturbance to cetaceans, ultimately assisting in the sustainability of the whale-watching tourism industry.

Sea otter (Enhydra lutris L.) diet research on Bering island in winter 2020/2021
Valentina Artemeva¹, Tomasz Ciesielski², Sergey A. Gorin³
¹Institut für Terrestrische und Aquatische Wildtierforschung (ITAW), Russia, ²Trondheim, Norway, ³LMSU Marine research centre, Moscow, Russia, Russia

The sea otter population of the Commander Islands has been gradually declining over the past decade and the surveys revealed a threatening reduction of the population size in
2019. The changing of the status of benthic communities of the littoral and sublittoral zones and thus, subsequent changes in food abundance has been suggested as one of the significant factors for the observed population decline. However, no studies on sea otter rations has been recently conducted. Therefore, the aim of this study was to examine current sea otter ration and compare it to available data from last decades. Scat samples were collected from the sea otters haul-out sites on the north-west of Bering Island in 2020 and 2021. The samples were washed and dried and the invertebrate and fish species composition in the scat sample was determined. The results showed that the main species in the sea otter diet compose of crustaceans (Telmessus, Hapalogaster, Pugettia, Dermaturus spp.), bivalve molluscs (Modiolus, Leukoma spp.) and sea urchins (Strongylocentrotus sp.). Comparing to the previous scat studies results from 2000-2006, it was found the sea otter ration has undergone significant changes. The current leading forage mollusc is Modiolus modiolus, the leading crustacean is Hapalogaster sp. Comparison of scat samples collected during 3 winter months showed that the frequency of occurrence of Modiolus modiolus in scat samples declines from December to February. On the other hand, the frequency of occurrence of fish in the scat samples increased at end of the winter. The study of the sea otter ration plays an important role in understanding the processes occurring in the benthic communities, which determine the diet composition of the sea otter. Commanders islands sea otter ration study will be continued to provide further information on the current foraging and feeding status of this endangered species.

Exploring a Policy Pathway to Prevent Lethal Entanglements of North Atlantic Right Whales (Eubalaena glacialis) in Commercial Fishing Gear in the Northwest Atlantic Ocean

Michael Asaro¹, Chao Zou¹, Marisa Trego¹, Burton Shank⁴, Colleen Coogan⁵, Sean Hayes⁶, Alicia Miller⁴, André Price⁴, alessandra huamani⁴

¹NOAA Fisheries, Woods Hole, MA, ²NOAA Fisheries Greater Atlantic Regional Fisheries Office, ³NOAA Fisheries, ⁴NOAA Fisheries Northeast Fisheries Science Center, ⁵NOAA Fisheries GARFO, Gloucester, MA, ⁶NOAA NEFSC, EAST FALMOUTH, MA

The North Atlantic right whale (Eubalaena glacialis) is an endangered large whale with approximately 360 individuals remaining. Since 1996, the Atlantic Large Whale Take Reduction Team has met to recommend measures to the National Marine Fisheries Service to reduce serious injuries and mortalities from entanglement in commercial fisheries. An array of management strategies has been implemented including time/area closures, dynamic management, gear modifications, and indirect line reductions but entanglements persist. Simultaneously, the development and deployment of bottom-stowed, remotely-retrieved vertical lines, or “ropeless” gear, has emerged with potential to prevent vertical line entanglements altogether, though with obstacles to wide scale implementation. To build a scientific consensus for future consideration, we explore a potential policy framework of direct management of vertical lines in commercial fixed gear fisheries through a line cap and trade program. Managers would determine allowable levels of entanglement mortality risk using the existing Decision Support Tool to estimate the relative risk of entanglement based on the spatial overlap of whales, fishing gear, and the relative lethality of different gear types. Once established, a spatially-explicit line allowance can be issued to applicable fixed gear commercial fisheries and subsequently a line cap can be set for individuals. This framework would allow fishers to decide how best to modify their fishing operations to deploy the allowable number of vertical lines. Options may include fishing ropeless systems, fishing one vertical line, reducing the number trawls, or purchasing a vertical line allowance from others who fish
below the allowable limit. The direct management of vertical lines could provide managers a stronger tool to control entanglement mortality risk and give fishers greater choice to configure gear, including deploying ropeless systems, to achieve the risk allowance.

**Photo identification study of the endangered short-beaked common dolphin, Delphinus delphis, in Dilek Yarimadasi, Aegean Sea.**

Claudia Ascencio¹, Aylin Akkaya¹, Tim Awbery²

¹UGent, Tivat, Montenegro, ²Marine Mammal Research Association, Derby, Derbyshire, United Kingdom

The short-beaked common dolphin *Delphinus delphis* is one of the most abundant cetaceans with a wide distribution. Despite this, the population in the Mediterranean Sea has experienced a severe decline in the past decades, therefore according to the IUCN Red List the Mediterranean population of the species is considered ‘Endangered’ with patchy distribution throughout the basin. The previous studies concentrated in the Aegean Sea are focused on the northern area leaving a gap of knowledge in the south. In order to increase knowledge in the southern Aegean Sea, the current study has focused on the residence patterns and the population size of the common dolphin at Dilek Yarimadasi. Data collection was gathered during boat surveys from summer and autumn 2019 and summer, autumn, and winter 2020. The survey was carried out with a random line transect sampling method. The boat consisted of a double platform observer and the photographs of focal groups were taken with a Canon 7D camera equipped with a 75-300mm lens. Mark-recapture photo-identification indicates seasonal residence pattern of common dolphins at Dilek Yarimadasi with a mean group size of 4 individuals. During each sighting, the subadult presence was noted in the area. The presence of common dolphins, with their calves, during warm and cold seasons highlights the importance of Dilek Yarimadasi as preferred habitat for this endangered species. This study has provided a baseline database for common dolphins at Dilek Yarimadasi and contributed to an increase in knowledge regarding this species in the Aegean Sea but further studies are necessary for effective conservation measurements.

**Movements and dive behavior of a blue whale tagged off Virginia, USA**

Jessica Aschettino¹, Daniel Engelhaupt¹, Amy Engelhaupt², Mark Cotter³, Joel Bell⁴

¹HDR Inc., Virginia Beach, Virginia, ²Amy Engelhaupt Consulting, Virginia Beach, Virginia, ³UMass Dartmouth, Virginia Beach, VA, ⁴Naval Facilities Engineering Systems Command Atlantic, Norfolk, Virginia

Under the U.S. Navy’s Marine Species Monitoring Program, researchers from HDR have documented individual blue whales (*Balaenoptera musculus*) off Virginia on three occasions during vessel and aerial marine mammal surveys – 11 April 2018, 10 February 2019, and 10 March 2021. A note was published (Engelhaupt et al. 2020) on the first two observations as they included the first documentation of blue whale sightings with photos off Virginia. During the March 2021 encounter, a Wildlife Computers SPLASH10-F-333 tag was deployed on an adult blue whale (estimated length of 21.1 m based on calculations from sUAS video) and collected data for nearly 10 days. Throughout the deployment, the whale traveled a total of 662 km and stayed within 73 km of its initial tagging location (mean distance = 36.5 km). The whale occupied an approximately 115 km² area off Virginia and North Carolina, exclusively in the Virginia Capes Operating Area – a training and testing range for U.S. Navy activities as well an area used for commercial and recreational fishing. Encountered 125 km from shore at a depth of 1,449 m, the blue whale spent most of its time in
deep water, although briefly moved onto shallower shelf waters. Nearly 30 hours of behavioral data were collected from the tag with 250 dives and 251 surfacing events logged. Dive depth ranged from 8.0—185.0 m (mean = 32.8 m) and dive duration ranged from 2.0—11.7 min (mean = 5.14 min). Surface duration ranged from 0.4—19.9 min (mean = 2.0 min). Based on histogram data that included 1175 total dives, 44.9 percent of dives were to depths of 10—20 m. This is the first satellite tag to be deployed on a blue whale off the eastern United States and provides a valuable dataset showing how this ESA-listed species utilizes these waters.

Chin-up calls: the Mediterranean Monk Seal vocalizes underwater!

Aurore Asso¹, Florence Erbs¹, Aliki Panou², Luigi Bundone³, Mike van der Schaar⁴, Giulia Mo⁵, Michel Andre⁶

¹Laboratory of Applied Bioacoustics, Technical University of Catalonia, BarcelonaTech (UPC), Vilanova i la Geltrú, Barcelona, Spain, ²Archipelagos, Environment and Development, Athens, Greece, ³Archipelagos - ambiente e sviluppo, Italia, Venice, Italy, Italy, ⁴UPC, Vilanova i la Geltrú, Spain, ⁵ISPRA, Rome, Italy, Italy, ⁶Technical University of Catalonia, Vilanova i la Geltrú, Barcelona, Spain

The Mediterranean monk seal (Monachus monachus) is amongst the most endangered pinniped species in the world. While its ecology and behavior is still poorly understood, the current knowledge of the species’ reproductive behavior suggests that it may use underwater sound but its vocal repertoire has so far only been described in air. Passive Acoustic Monitoring is a valid method to monitor aquatic mammal presence and interaction. Here, we report on one opportunistic encounter of a subadult male monk seal with a free diver in the island of Alonissos, Greece, on September 9th, 2020. The encounter occurred under water, at a 3 meters depth in front of a beach. The videos and associated sounds recorded by the diver provided evidence of the monk seal producing broadband impulsive sounds synchronized with head movements. Seventeen calls were recorded on video, 12 of which were analysed using signal wave forms. The vocalizations were defined as “chin-up calls” (CUC). Average duration of the CUCs was 0.016 second, and inter-call-interval (ICI) of 8 calls produced in sequence was 0.685 second. This is the first report of Mediterranean monk seal vocalizations underwater. This type of impulsive sounds has not been described in the Hawaiian monk seal’s underwater repertoire nor in the Mediterranean monk seal’s aerial vocalizations. It is likely that the species’ underwater repertoire is composed of more sound types, as is in other seals species as well. Encouraged by this first opportunistic record, a collaborative effort has started in October 2020 to conduct a more exhaustive and systematic acoustic research on the Mediterranean monk seal.

Anthropogenic Impact on Masking in Antarctic Humpback Whale Populations: The Case for Regulated Sustainable Antarctic Tourism

Claire Atkins-Davis¹, Doug Nowacek², Alison Stimpert³, James Davis⁴

¹Marine Mammal Research Association, ²Duke University, Beaufort, North Carolina, ³Moss Landing Marine Laboratories, ⁴Guilford Institute, Greensboro, NC

Antarctica is an iconic representation of the last true wilderness. Unfortunately, the draw to visit this wilderness has become a driver of its own demise. Ocean physics facilitated marine species to evolve using sound as a primary sensory modality for interacting with their environment. Marine animals use sound to forage, reproduce, communicate, navigate, and avoid predators. Anthropogenic vessel noise has become ubiquitous throughout the world’s oceans, creating an acoustic fog causing behavioral,
acoustical, and physiological impacts. Since the establishment of the International Association of Antarctic Tourism (IAATO) in 1991, tourism has increased by 488% around the Western Antarctic Peninsula (WAP), a critically vulnerable habitat for polar keystone species. Our research examines WAP tourist vessel noise emissions, assessing the overlap with humpback social sounds resulting in the masking of vital acoustic cues. We analyzed the signal-to-noise ratio (SNR) of humpback whale social sounds to ambient noise levels in order to establish a baseline measurement in efforts to quantify increases in ambient noise levels from tourism vessel activity. We compared SNR differences using data from 20 deployed DTAGS, analyzed in Raven software, isolating signal intensity of the vocalizations from adjacent ambient noise. Vessel speed, tonnage, and geospatial density were analyzed for spectral influx and superposition of vessel noise. Our results are consistent with previous geospatial/temporal distribution studies, indicating high overlap of tourism vessel tracks with humpback whale population distribution, strongly suggesting spectral overlap for masking. Our results are consistent with previous geospatial/temporal distribution studies, indicating high overlap of tourism vessel tracks with humpback whale population distribution, strongly suggesting spectral overlap for masking. Our results are consistent with previous geospatial/temporal distribution studies, indicating high overlap of tourism vessel tracks with humpback whale population distribution, strongly suggesting spectral overlap for masking. Our study gives preliminary findings of the impact of vessel noise pollution from WAP tourism. Noise has been defined as a pollutant and should be regulated as any other transboundary pollutant. Future research is required to implement an ecosystem-based approach to mitigate anthropogenic noise. Our recommendations are: time-area closures; caps on vessel count, size, distance, speed, and distribution; and, noise-focused environmental impact assessments from tourism activities.

Acoustic Identification of Dolphins using Deep Learning Techniques

**Georgia Atkinson**, Per Berggren, Matt Sharpe, Cameron Trotter, Kirsten Crane, Nick Wright, A. Stephen McGough

'Newcastle University, Newcastle upon Tyne, Tyne and Wear, United Kingdom, 'Newcastle University, Newcastle Upon Tyne, gb, 'Newcastle University, Newcastle, United Kingdom, "School of Computing, Newcastle University, Newcastle upon Tyne, Tyne and Wear, United Kingdom

Passive acoustic monitoring (PAM) is an increasingly used method for researching marine mammals, especially cetaceans. Compared to visual based monitoring methods, PAM provides a less expensive method to monitor the occurrence and behavioural ecology of species and individuals over long temporal scales that is not affected by daylight or sea state. However, PAM generates overwhelming quantities of data, warranting an automated system for data processing to identify relevant signals from large amounts of ambient noise. For cetaceans, this involves detecting and classifying vocalisations from species, populations, pods, and individuals. In this study, we develop an automated system to detect and classify signature whistles of *Tursiops truncatus* to identify individuals within a population. The data used were collected using SoundTrap recorders deployed at three locations in the North Sea off the North East of England, UK where *Tursiops truncatus* frequent. The automated system is split into two phases: detection and classification. The first phase receives raw audio as input which is segmented and transformed into spectrograms. These spectrograms are then fed into a convolutional recurrent neural network to detect the start and end times of determined whistles. Output from the detection phase is then post-processed to contain only the audio segments labelled as whistles whilst retaining the start and end times. These are then passed to the classification phase. The classification phase builds upon the signature identification (SIGID) method for signature whistles. Whistles are first clustered into categories based upon their spectrograms; the SIGID methodology is then applied to determine if the whistles in a category are signature whistles. These signature whistles are
outputted along with timing information for confirmation. The system significantly reduces the manual analysis needed to accurately develop signature whistle catalogues, freeing up time for analyses and reporting, making PAM an even more efficient method for dolphin research.

Seasonally stressed? Varying metabolic biomarkers in humpback whales (Megaptera novaeangliae) in Alaska and Hawaii
Shannon Atkinson DeMaster, Adam Pack, Heidi Pearson, Valentina Melica, Kendall Mashburn, Marc Lammers, John Moran, Suzie Teerlink, Lars Bejder, Jens Currie, Stephanie Stack, Andrew Szabo, Kelly Cates, Martin van Aswegen

1 University of Alaska Fairbanks, 2 University of Hawaii at Hilo, Hilo, Hawaii, 3 University of Alaska Southeast, Juneau, Alaska, 4 University of Alaska Fairbanks, College of Fisheries and Ocean Sciences, Juneau, AK, 5 University of Alaska Fairbanks, Juneau, AK, 6 Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, Hawaii, 7 NOAA Fisheries/Alaska Fisheries Science Center, Juneau, AK, 8 NOAA Fisheries, Juneau, Alaska, 9 Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, Hawaii, HI, 10 Pacific Whale Foundation, 11 Alaska Whale Foundation, Petersburg, Alaska, 12 University of Alaska Fairbanks, Douglas, AK, 13 Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Honolulu, Hawaii

Understanding the metabolic physiology of migratory whales is key to predicting their behavior during times of large-scale changes in the marine environment. Differences in the metabolic costs of humpback whales (Megaptera novaeangliae) on the Hawaiian breeding grounds versus their Alaska feeding grounds are likely present, with a focus on calving and breeding in Hawaii and feeding in Alaska. Corticosteroid concentrations in the blubber of these whales can be used to understand how pronounced these differences may be, as well as serve as biomarkers of their overall metabolic well-being. Cortisol and corticosterone concentrations in the blubber of whales near Juneau, Alaska in summer 2020 were compared to the concentrations of humpback whales in Hawaii during the previous season. There were no significant differences in cortisol and corticosterone concentrations between male and female humpback whales in Hawaii, thus data for both sexes were combined for preliminary analyses. Approximately 25.0% (6/24) and 55.3% (26/47) of whales had cortisol and 62.5% (15/24) and 78.7% (36/47) had corticosterone concentrations that were non-detectable in Alaska and Hawaii, respectively. Of the whales whose values were detectable, significant differences were seen in the mean concentrations of both blubber cortisol and corticosterone, with whales in Hawaii lower than those in Alaska (both p<0.001). The mean cortisol and corticosterone concentrations were 5.8 and 6.1 times greater in Alaska than Hawaii, respectively. When assessed by month, there was increasing variability from winter to late summer of both cortisol and corticosterone concentrations. These variable hormone concentrations reflect the homeostatic shift that migratory whales undergo in order to remain metabolically stable in sub-arctic environments where they feed and sub-tropical environments where they fast and reproduce. Developing the routine use of metabolic biomarkers is an emerging technique to better understand environmental information that these sentinels of the marine environment hold.

How to spy on a beluga: Assessing drone disturbance in free-ranging whales
Jaclyn Aubin, Marie-Ana Mikus, Robert Michaud, Daniel Mennill, Valeria Vergara

1 University of Windsor, 2 Ocean Wise Conservation Association, Vancouver, BC,
Drones have quickly become an invaluable tool for many marine mammal researchers. Although initially touted as non-invasive, drones are now recognized as a potential source of disturbance for wildlife, including marine mammals. In addition, research shows that species differ considerably in their responses to drones, highlighting a need for species-specific studies and guidelines. Here we present the first study examining the impact of drones on belugas (*Delphinapterus leucas*). Using 512 focal group follows obtained over 41 hours of drone footage of free-ranging belugas in the St. Lawrence Estuary, we recorded beluga disturbance behaviours in response to a Phantom 4 Pro drone across a range of conditions. We hypothesized that belugas would show increased reactions to the drone when exposed to more intense visual and acoustic drone cues, and that certain groups would be more sensitive to drone disturbance than others. We observed a total of 22 sudden dives, which we interpreted as evasive reactions to the drone. We constructed a series of generalized linear mixed effect models incorporating various variables that have been shown to impact the likelihood of drone disturbance in other marine mammals, including drone altitude, approach path, and the presence of offspring. We then used AIC model selection to determine which variables impacted the likelihood of belugas reacting to the drone. Although drone altitude best explained the occurrence of sudden dives, much of the variance in sudden dives was attributed to sampling date, a random effect included in all ranked models. This suggests that other unmeasured environmental variables may also affect the likelihood of evasive reactions. Our findings provide the basis for a series of recommendations for future drone studies of belugas, providing guidelines to minimize potential disturbance of study subjects.

**Humpback whale photo-identifications from Guerrero indicate southern Mexico is similar to Central America as a wintering area of whales that feed primarily on the US West Coast**

**Katherina Audley¹, Andrea Jacqueline Garcia Chavez², Raul Ramirez³, Elana Dobson⁴, Kiirsten Flynn⁵, Ted Cheeseman⁶, John Calambokidis⁷**

¹Whales of Guerrero, Portland, OR, ²Whales of Guerrero, Zihuatanejo, Mexico, ³Whales of Guerrero, Salamanca, Guanajuato, Mexico, ⁴Cascadia Research Collective, ⁵Cascadia Research Collective, Olympia, Washington, ⁶Southern Cross University, ⁷Cascadia Research Collective, Olympia

Until recently, little has been known about where humpback whales sighted in Southern Pacific Mexico breeding grounds go to feed. A 7-year study in the S Pacific Mexican state of Guerrero has provided new insights into the migration patterns of N Pacific humpback whales. 408 small boat surveys were conducted in Guerrero every January–March from 2014–2020. A total of 763 humpback sightings were recorded and matched to N Pacific feeding ground sightings. There has been increased interest in the winter breeding areas of humpbacks in the North Pacific due to NOAA’s recognition of Distinct Population Segments (DPSES) based on wintering areas. These units have different statuses under the US Endangered Species Act and their connections to feeding areas are important given increased levels of entanglements and other anthropogenic mortalities in recent years. Humpbacks wintering off Central and Northern Pacific Mexico are considered threatened and migrate to a wide range of N Pacific feeding grounds. In contrast, humpback whales wintering off Central America are considered endangered and almost exclusively migrate to the US West Coast. Of 386 whales identified in Guerrero, just over 80% were known whales that feed off the US West...
Coast, suggesting this area serves as a wintering area almost solely for US West Coast whales. This corresponds to seven whales identified in S Mexico in 2005 which were also matched to the US West Coast, indicating that S Mexico has likely served this role in the past. The proportion of Guerrero whales matching the US West Coast did not vary much by year (79-90%) or month (74-82%). These results are surprising given that Guerrero (where most photos-ids came from) is much closer to Bahia Banderas (500 km), one of the primary mainland Mexico wintering areas, than it is to Central America (>1,000 km).

**Seasonal distribution of the fin whale (Balaenoptera physalus) in Antarctic and Australian waters based on passive acoustics**

**Meghan Aulich¹**, Robert McCauley², Brian Miller³  
¹Centre for Marine Science and Technology-Curtin University, Gosnells, Western Australia, Australia, ²Curtin University Centre for Marine Science and Technology, Perth, Western Australia, Australia, ³Australian Antarctic Division

The fin whale has a global distribution, with all populations listed as vulnerable, yet little is known about the distribution and movements of the Southern Hemisphere sub-species, *B. physalus quoyi*. This study uses passive acoustic monitoring as a tool to identify the seasonal distribution and migratory pathways of fin whales as they disperse from Antarctic to Australian waters. Sampling was conducted from 12 sites in Antarctic and Australian waters from 2002-2019, providing a total of 51 annual records. Acoustic presence in Antarctic waters indicates a yearly pattern of presence of fin whales at the Southern Kerguelen Plateau from February-June, with a mean of 59 call days and 5.01 total pulses/recording hour, per year. At the Dumont d’Urville site, acoustic presence was identified from February-May with a mean of 45 call days and 2.95 total pulses/recording hour, per year. In comparison, the Casey site had limited presence of fin whales with a mean of only 11 call days and 0.44 total pulses/recording hour, per year. Arrival of fin whales in Australian waters occurred first on the west coast at Cape Leeuwin and the Perth Canyon with a seasonal presence identified from April-October. Cape Leeuwin and the Perth Canyon had a mean of 51.7 and 55.5 call days and 1.77 and 9.51 total pulses/recording hour, per year respectively. On Australia’s east coast, fin whale seasonal presence was identified at Tasmania and Tuncurry from May-October, with a mean of 40 and 35.5 call days and 1.51 and 0.91 total pulses/recording hour, per year respectively. The consistent seasonal trends in presence, number of call days and detections provides valuable information on the distribution and migratory patterns of this Southern Hemisphere sub-species of fin whale, and can help aid in monitoring the recovery of this vulnerable species.

**Investigating beluga response to tourist vessels using a simple camera system in the Churchill estuary**

**Emma Ausen¹**, Marianne Marcoux², Wayne Chan², David Barber²  
¹Winnipeg, MB, ²Fisheries and Oceans Canada, Winnipeg, Manitoba

Whale tourism is a popular means of educating the public about wildlife conservation. Whale watching boats can disturb the observed species, however. Whales have been observed displaying avoidance tactics to tourism vessels, including diving and fleeing. The response to tourist vessels can vary based on species, population, and location. There is evidence that some populations may become habituated to tourist vessel presence over time. Reactions to tourist vessels may interrupt important ecological functions, including feeding, and for this reason it is important to monitor whale watching operations. The Churchill River estuary is habitat for Western Hudson Bay beluga whales.
(Delphinapterus leucas) from June to September. Beluga in the Churchill River estuary have a unique response to small boats, such as kayak and Zodiac whale watching tours, often displaying interactive behavior that is a major draw for ecotourism to the region. While this behavior has been quantified using observational studies, direct measurement of beluga response would provide needed information for tourism management that meets the needs of tour operators and insures no harmful disturbance to the whales.

Here, we present results from a study evaluating beluga response to the vessels that share the Churchill River estuary. We used a time-lapse photographic system to identify surfacing beluga in a section of the estuary using oblique photos. Real-life distances between pixels in photos were calculated and verified using control points taken in the estuary. Distances between surfacing beluga and vessels captured in photos were compared with randomly generated distances using Euclidean distance analysis. Results from this study will quantify the behavioral response of belugas in the Churchill River estuary to tourist vessel traffic. Greater understanding of the interaction between boats and belugas will assist in management as ecotourism and whale watching activities continue in the Churchill River estuary.

Evaluation of the Efficacy of Artificial Neural Networks (ANNs) for acoustic repertoire analysis of cetacean species
Maia Austin¹, Joëlle De Weerdt², Jose David Palacios-Alfaro³, Nicola Ransome⁴, Laura J. May-Collado¹
¹University of Vermont, Burlington, VT, ²Association ELI-S, Gujan-Mestras, France, ³Independent reseacher, San Jose, Costa Rica, ⁴Murdoch University

The increasing use of autonomous acoustic recorders in long-term monitoring of marine mammals must be accompanied of analytical tools that can efficiently and accurately identify species. Given the complexity and nuance of cetacean acoustic signals, traditional analysis programs have struggled to achieve rates of accuracy comparable to human classification. As such, a number of programs have been developed that utilize Machine Learning (ML), a system loosely inspired by human cognition that takes inputted data and categorizes it based on a set of weighted parameters. While these have shown great promise in individual studies, they have not yet been directly compared. Here we compared the efficacy of four programs: ARTWarp, DeepSqueak, Luscinia, PAMGUARD, and SASLab Pro. Each requires a different level of user oversight and input. They can be used in different situations based on species of interest, recording length, and signal quality. Datasets tested included Guyana dolphins (Sotalia guainensis), Bottlenose dolphins (Tursiops truncatus), Pantropical Spotted Dolphins (Stenella Attenuata), and false killer whales (Pseudorca crassidens). The chosen species represent a wide variety of signal structure, length, and frequency range, allowing for greater understanding of program capabilities. Results from this study will assist researchers in implementing analytical tools across large datasets to analyze and categorize individual whistles, as well as full repertoires of signals across populations and species.

It’s in the bones: Tracking mercury dynamics in the Aleutian Islands, Alaska utilizing ancient Otariid bones
Julie Avery¹, Nicole Misarti², Caroline Funk³, Mary Keenan¹, Todd O’Hara⁴, Lorrie Rea⁵
¹University of Alaska Fairbanks, Fairbanks, Alaska, ²University of Alaska Fairbanks, Water and Environmental Research Center, Fairbanks, Alaska, ³University at Buffalo, ⁴University of Alaska Fairbanks, Fairbanks, AK, ⁵University of Alaska Fairbanks, Fairbanks, Alaska
Currently, mercury (Hg) enters the environment from both anthropogenic and natural sources. Once deposited in the environment and methylated (monomethylmercury), Hg can enter the marine food web. Mercury presence in Alaskan Arctic waters has limited direct local industrial inputs relative to other regions. Natural sources of Hg in Alaska include volcanic activity, river systems, and melting permafrost. However, global atmospheric processes also transport and deposit Hg from distant sources into Arctic environments. Long-lived, top predators serve as sentinels for environmental Hg as they bioaccumulate (lifetime accrual) and biomagnify (increasing with higher trophic position) this contaminant. Long-term data sets are essential for determining deeper temporal patterns and biological or environmental factors that contribute to Hg dynamics in these environments including exposure of Arctic marine mammals. We examined bone samples from Aleutian otariids (Steller sea lions, *Eumetopias jubatus*, and Northern fur seals, *Callorhinus ursinus*) from 4000 to 200 calibrated years before present (cal BP) excavated from Sanak Island in the eastern Aleutian Islands to determine if relatively high total mercury concentrations ([THg]) found in modern otariids increased from historic concentrations. Bone specimens showed large variation in [THg] (8 to 1640 ppb; n=36). Surprisingly, the greatest concentrations were observed 3500 cal BP during a period of higher volcanic activity. Significant differences were observed in [THg] based on bone type (p=0.004; spongy 145.3±130.9 vs. compact 76.4±68.4). Differences in metabolic activity and composition of bone types likely contribute to these observed differences. Compact bone likely provides a multi-year average while spongy bone may represent recent [THg] exposure prior to death. Preliminary data also indicates [THg] was greater in cool compared with warm climatic periods (89.2±76.2 vs. 50.9±41.4 ppb; p=0.036) and suggest environmental or biological factors altered during climatic shifts may contribute to [THg] in bone of top predators.

**The Colombian Caribbean Sea, a tropical habitat for the vulnerable sperm whale (*Physeter macrocephalus*)?**

Isabel Cristina Avila¹, Nohelia Farías-Curtidor², Luisa Castellanos¹, Dalia Barragán-Barrera², Karina Bohrer Do Amaral¹, Carlos Orozco¹, Jorge León¹, Vladimir Puentes⁷

¹Universidad del Valle, Colombia, Cali, Valle, Colombia, ²Fundación Macuáticos Colombia, Medellín, Colombia, ³Independent researcher, Bogotá, Colombia, ⁴Universidade Federal do Rio Grande do Sul, ⁵Independent researcher, Archipelago of San Andres, Old Providence and Saint Catherine, Colombia, ⁶Anadarko, Colombia, Colombia, ⁷Anadarko, Colombia, Bogotá, Colombia

Sperm whale (*Physeter macrocephalus*) is a cosmopolitan marine mammal, currently globally classified as a vulnerable species. We studied the sperm whales in the Colombian Caribbean by identifying ecological aspects (behaviour, rate encounter, group structure and density) with data coming from offshore dedicated surveys. Also, we presented for the first-time the potential distribution of sperm whales in the Colombian Caribbean, by including sighting and acoustic data obtained during dedicated surveys, published information, and opportunistic encounters registered between 1988 and 2020 (N=66). Observations during dedicated surveys were conducted on oil and gas exploration vessels in 68,904.7 km² and 703 days of observation effort between 2011 and 2016. We registered 98 individuals forming 50 groups, a density of 1.5 individuals per 1,000 km². Sperm whale density in the Colombian Caribbean found in our study is higher to values reported in previous studies of the Caribbean. Moreover, to obtain the potential distribution of sperm whales, different Maxent models were built with uncorrelated environmental variables at five different level depths (on the surface, ~0.5 m,
~500 m, ~1,000 m, ~1,500 m and ~2,000 m deep). The model built at ~1,000 m depth showed the best performance, and according to it, areas of high probability occurrence of sperm whales include South and North-East Colombian Caribbean over the continental shelf break to waters up to ~3,000 m deep, and nearby the Archipelago of San Andres, Old Providence and Saint Catherine in the North-West. This area may be an important tropical habitat for sperm whales, where they perform vital activities such as socializing, resting, breeding, and feeding. Our study underlines the importance of monitoring marine mammals offshore and identifies the potential distribution of sperm whales for the Colombian Caribbean, which support management plans for this vulnerable species, which is currently facing several threats in the Caribbean Region.

Acute and Chronic Behavioral Effects of Kelp Gull Micropredation on Southern Right Whale Mother-calf Pairs off Peninsula Valdés, Argentina

Taylor Azizeh1, Kate Sprogis2, Raquel Soley, Mia Nielsen3, Marcela Uhart6, Mariano Sironi7, Carina F. Marón8, Lars Bejder9, Peter Teglberg Madsen10, Fredrik Christiansen11

1San José State University, Aarhus, Denmark, 2Marine Bioacoustics Lab, Aarhus University, Australia, 3Freelance Marine biologist, 4MMO & PAM, Barcelona, Andorra, 5University of Exeter, EXETER, United Kingdom, 6University of California, Davis and Universidad del Centro de la Provincia de Buenos Aires, Argentina, Puerto Madryn, Chubut, Argentina, 7Instituto de Conservación de Ballenas, Buenos Aires, Argentina, Buenos Aires, Argentina, 8Universidad Nacional de Cordoba and Instituto de Conservacion de Ballenas, Argentina, 9Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, Hawaii, HI, 10Aarhus university, 11Aarhus Institute of Advanced Studies, Aarhus, Denmark

Kelp gulls (KG, Larus dominicanus) feed on the skin and blubber of living southern right whales (SRW, Eubalaena australis) off Peninsula Valdés (PV), Argentina. The whales respond strongly to KG micropredation by changing their immediate (acute) behavior during attacks and their overall (chronic) surfacing pattern and body posture to minimize gull exposure. The energetic and large-scale behavioral consequences of these attacks are unknown. To address this, we quantified the effect size of both acute (during attacks) and chronic (not during attacks) responses by comparing the respiration rates, swim speed, and nursing behavior of PV SRW to undisturbed (control) SRW mother-calf pairs in Head of Bight, Australia, using unmanned aerial vehicle focal follows. Even when gulls were not attacking, PV SRW mothers and calves demonstrated ~50 and ~25% higher respiration rates, respectively, than in Australia. During attacks, PV calf respiration rates increased by an additional 10%. PV SRW mothers also frequently (>76% of respirations) exhibited chronic irregular breathing posture, causing the whale to potentially be expending extra energy by working against its natural buoyancy. Despite no significant increase in average maternal swim speed, 76 and 90% of gull attacks elicited strong behavioral reactions from mothers and calves, respectively. Overall, PV calves spent less time nursing during individual bouts compared to Australia but entered suckling position more frequently. Furthermore, kelp gulls seemed to show a preference for attacking previously wounded calves and at a higher rate. These chronic and acute behavioral effects may carry energetic costs, which could have long-term consequences on SRW survival and reproduction.

Environmental characterization of Port Hilford Bay, Nova Scotia, Canada; site of the Whale Sanctuary Project

Amanda Babin, Whale Sanctuary Project,
Tangier, Nova Scotia

There is a paradigm shift happening around the practice of holding cetaceans in captivity. The Whale Sanctuary Project is creating a sanctuary for cetaceans as has been done for primates and large cats. After an extensive search, it was announced in February 2020, that Port Hilford Bay (“the bay”) will be the sanctuary site for beluga whales and with the potential for a separate area for orcas. The bay is large (~5 km long, ~2 km wide) and open to the southeast where there are outer shoals providing protection from the predominant southwesterly winds. An area in the southwest section of the bay has been designated for the 100-acre sanctuary. Environmental analyses from 2019-2021 will be reported, including physical (depth/bathymetry, hydrodynamics, water temperature, ice and weather conditions, and acoustics), chemical (water and sediment quality, salinity, and dissolved oxygen), and biological (coliform, plankton and invertebrates, species inventory) components. The sanctuary area has a variety of depths and substrate types, and a tidal range of 2.6 m. Water current speeds averaged 0.033 m/s (max. 0.36 m/s), with a flushing rate of 1 day. Daily average water temperature ranged from -0.2 to 19.8°C (Mar-Oct), and in the air ranged from -3.5 to 23.8°C (Feb-Oct). Underwater noise levels had an overall median of 92.57 dB (re 1 µPa; 0.025-125 kHz; sampling rate 288 kHz), or 86.24 dB after applying the mid-frequency cetacean weighting function. Extensive marine and freshwater and sediment samples were collected and tested using the RCAP-MS package from Bureau Veritas for nutrients, metals, and coliform levels. Salinity of marine samples ranged from 29-31 ppt. Coliform units were not detected in most marine samples. A desktop inventory of species within 100 km of the site enumerated ~750 species from plants to mammals, and field surveys are being conducted to ground-truth these results.

Impacts of wind farm operations on local pinniped populations: A review

Lauren Baier1, Jacalyn Toth Sullivan2

1Stockton University, Beachwood, New Jersey, 2Stockton University, Galloway, NJ

Lauren Baier1 and Jacalyn Toth1

1. Stockton University, School of Natural Sciences and Mathematics, Marine Science Program

As the need for alternative and sustainable energy sources increases, the construction and operation of offshore wind farms is becoming more frequent in the northeastern United States. Understanding how turbines impact surrounding ecosystems is essential for conscientious development of future wind energy systems. Various studies suggest that marine mammals are impacted at all stages of construction, maintenance, and operation, with noteworthy distinctions between pinnipeds and cetaceans. This review summarizes the methods, results, and significant conclusions of previous studies examining the effect of wind operations on local pinniped populations. Many of these studies originate in Europe, where approximately 69 offshore wind farms are installed. Numerous studies investigating pinniped acoustic and behavioral responses suggest wind farm impacts on pinnipeds are primarily neutral and, in some cases, positive. Different stages of wind farm construction will be discussed - each of which may generate distinct behavioral reactions. For example, pinnipeds affected during wind farm construction phases only may exhibit modified behavior during initial pile-driving operations. Pinniped auditory thresholds, along with sound frequencies related to activities during wind farm construction will be summarized. In addition, suggested positive impacts will be discussed, including the creation of artificial reef communities, increased fish and invertebrate biomass, and subsequent increased foraging opportunities for pinnipeds. This review of pinniped populations co-occurring alongside varying stages of wind farm operations will
increase awareness of potential impacts (positive, neutral, and negative) to these important apex predators. As wind farm development becomes common in coastal environments, understanding outcomes from prior studies will help inform monitoring and impact assessments for future wind farm construction and operation.

Methodology and results of the study of the individual behavior of the Caspian seal (Pusa caspica) during spring haulouts on the islands

Assel Baimukanova1, Roman Jashenko2, Mirgaly Baimukanov3
1Institute of Hydrobiology and Ecology, Almaty, Kazakhstan, 2Institute of Zoology of the Republic of Kazakhstan, Almaty, Kazakhstan, 3Institute of Hydrobiology & Ecology, Almaty, Kazakhstan

Key words: Caspian seal behavior, behavioral acts, ethogram

The Caspian seal (Pusa caspica) is the only marine mammal of the Caspian Sea, endemic, included in the IUCN Red List as an endangered species. The species has a similar status in the legislations of all Caspian littoral countries.

Seals are semi-aquatic animals, most of the time, they form large haulouts on islands and shoals, but there is little information about behavior. During 2015–2021, studies on seals' individual and group behavior on haulouts were made in the Kazakhstani part of the sea. This thesis provides data about the individual behavior of seals during spring haulouts.

We collected materials at different times: morning, noon, evening. Previously, the assessment of the abundance on a particular haulout was carried out by shooting from quadrocopters. The researchers crawled up to seal aggregation, installed video cameras, and conducted visual observations about 30 to 100 meters from the nearest seals. The following data points were entered in the protocol: date, time, location, cloudiness, wind direction and speed, air temperature, anxiety factors.

The total number of analyzed video materials was 23 hours. Each object-seal selected for analysis was assigned as the individual number. Formal and functional analysis was performed when viewing video frames. The formal analysis described 44 elements and 56 behavioral acts (BA). Then all BAs were described in detail, and their timing and duration were specified. The functional analysis of the BAs was grouped into seven categories: satisfaction of physiological needs of the organism, observation and reaction to external stimuli, peaceful behavior, preventive behavior or threat, aggressive behavior, individual distance, locomotion.

The research results can be used in the future to assess the influence of natural and anthropogenic factors on seal haulouts.

The research was carried out with financial support from Kazakhstan's Ministry of Ecology, Geology, and Natural Resources (Grant BR10264205).

Unintended Consequences: Common Bottlenose Dolphin Associations with an Aquaculture Operation in Hawai‘i Lead to Impacts on Spinner Dolphins and other Delphinids

Robin Baird1, Annette Harnish1, Enrico Corsi2, Annie Gorgone1, Doug Perrine4, Alicia Ward4, Cynthia Hankins4, Emily Sepeta4
1Cascadia Research Collective, Olympia, WA, 2Florida International University, Olympia, WA, 3Beaufort, 4Kailua-Kona, HI

Siting mariculture operations in the range of protected species can have unintended consequences. A kanpachi (Seriola rivoliana) fish farm was started in 2006 just offshore of Makako Bay, Hawai‘i Island, a traditional daytime resting area for spinner dolphins, and within the range of three other resident odontocete species. Almost daily common bottlenose dolphin associations with the farm have been reported since 2007, but little
information is available regarding the nature of these associations. We analyzed photos from 33 bottlenose dolphin encounters at the farm from 2007-2021 in the context of over 350 encounters in Hawaiian waters from 2000-2021, as well as extensive citizen science encounters and data from five satellite-tagged bottlenose dolphins. We identified 36 unique individual bottlenose associated with the farm, about a quarter of the estimated island-associated population. New individuals continue to be documented, suggesting ongoing recruitment to the farm and/or incomplete sampling. One adult male was documented 17 times at the farm over 11 years. A crawl model of satellite-tag data also revealed one individual that may have associated with the farm that was not documented there using photo-identification. Underwater observations indicate that dolphins are feeding on escaped kanpachi, and may have developed behaviors that encourage fish to escape. Association analyses indicate that farm-associated dolphins are widely but not uniformly distributed throughout the social network, suggesting that the behavior of associating with the farm may continue to spread within the population. Bottlenose dolphin aggression towards other delphinids in Hawai‘i appears to be increasing and disproportionately involves farm-associated individuals, with aggressive interactions most frequently directed towards spinner dolphins, but also including pantropical spotted dolphins and false killer whales. There is anecdotal evidence that spinner dolphins may have largely abandoned Makako Bay as a resting area since aggressive interactions started. Combined, our results demonstrate impacts on multiple protected species.

Climate Change-induced Terrestrial Habitat Loss and the Long-term Viability of the French Frigate Shoals Hawaiian Monk Seal Population

Jason Baker¹, Albert Harting², Thea Johanos³, Josh London⁴, Michelle Barbieri⁵, Charles Littnan⁶

¹Protected Species Division / NOAA / PIFSC, Honolulu, HI, ²Harting Biological Consulting, Bozeman, MT, ³Hawaiian Monk Seal Research Program, Honolulu, HI, ⁴Alaska Fisheries Science Center's Marine Mammal Laboratory / NOAA Fisheries, Seattle, WA, ⁵NOAA National Marine Fisheries Service, wailaua, hi, ⁶Society for Marine Mammalogy, Honolulu, Hawaii

Hawaiian monk seals require terrestrial habitat for parturition, nursing, molting, and resting space that is both safe from shark attack and within commuting distance to marine foraging habitat. Terrestrial habitat in the Northwestern Hawaiian Islands (NWHI) is threatened by sand erosion due to storms and global sea-level rise. We examined habitat loss to date and prospects for the future viability of the monk seal population at French Frigate Shoals. This atoll’s islets have been shrinking for decades and by 2018, the second, third, and fourth largest had virtually disappeared. This has resulted in unprecedentedly low pup survival from birth to weaning, with deaths attributable to shark predation and drowning associated with storms or high tides. Only 57% of French Frigate Shoals pups survived to weaning in 2018 compared to an average 95% throughout the rest of the NWHI. French Frigate Shoals seals access 42%, and likely have near exclusive access to 31%, of total NWHI foraging habitat. If the atoll eventually becomes uninhabitable due to total loss of terrestrial habitat, this significant portion of foraging habitat would be inaccessible to seals, thereby limiting potential for the species’ recovery. Tern Island comprises three-quarters of the remaining terrestrial habitat at French Frigate Shoals. Historical seal counts suggest that Tern Island could accommodate the entire current population if all the remaining islets in the atoll were to subside. Unfortunately, there are lethal seal entrapment hazards associated with a deteriorating seawall at Tern Island. The French Frigate Shoals monk seal population may not persist without intervention to improve the
quality, if not quantity, of terrestrial habitat. Man-made hazards on Tern Island should be eliminated and, in the longer term, preservation and perhaps restoration of terrestrial habitat will likely be essential to ensure the French Frigate Shoals monk seal population remains viable.

Whole Genome Sequencing of Russian Polar Bears
D Neve Baker¹, Eric Regehr², Beth Shapiro³
¹University of California, Santa Cruz, ²University of Washington, Seattle, WA, ³University of California, Santa Cruz, Santa Cruz, CA

The genetic structure of polar bears (Ursus maritimus) is incompletely understood and many of the 19 designated subpopulations – particularly those partially or fully in Russian territory – are data deficient, leaving gaps in scientific understanding of global polar bear diversity and presenting challenges to management. Characterizing the Holarctic genetic diversity of polar bears and identifying potentially diverged populations is important to understanding how genetic variation and potentially local adaptation is structured across the polar bear distribution, and how this may change with loss of sea ice resulting from climate change. Given the challenges of exporting biological samples from Russia, museum samples collected pre-CITES (late 19th and early 20th century) present a useful alternative for genetic sequencing. As whole genome sequencing and assembly has become more affordable, genomic data are becoming increasingly accessible and useful for conservation and management. Whole genomes are a powerful tool for traditional population genetics, as well as for broader evolutionary and demographic applications.

Here we present the results of high-coverage full genome resequencing from six historic polar bears from three Russian subpopulations – Barents Sea, Kara Sea, and Laptev Sea. We use these data to estimate genome wide heterozygosity, identify runs of homozygosity to test for inbreeding and admixture, and infer the demographic history of these populations. We then combine these six new genomes with 24 previously sequenced polar bear genomes from five other subpopulations to serve as a geographically representative dataset of range-wide polar bear diversity. By analyzing these genomes together, we assess polar bear population structure, diversity, and patterns of isolation and connectivity across their distribution.

With these new data, we describe how polar bears from the Russian Arctic fit more broadly into global polar bear metapopulation, helping to fill a crucial data gap in our understanding of Holarctic polar bear diversity.

Modelling Patchiness of Small Delphinid Group Sizes in the Eastern Tropical Pacific
Pooja Balaji¹, Frederick (Eric) Archer²
¹University of California, San Diego, ²Southwest Fisheries Science Center, La Jolla, California

Tuna purse seine vessels fishing for Thunnus albacares was a cause for significant incidental bycatch of dolphins and subsequent depletion of their populations in the Eastern Tropical Pacific (ETP) in the 1960s and 1970s, until the establishment of the United States Marine Mammal Protection Act (US MMPA) in 1972. Some of the most heavily affected species are spotted and spinner dolphins (Stenella attenuata and S. longirostris), as well as common dolphins (Delphinus delphis), the abundances of which have been estimated to have been reduced by up to one-fifth of their size. Despite a marked decrease in dolphin mortality and incidental take post implementation of the US MMPA, populations have not been recovering at expected rates. One hypothesis for this is that repeated chase, encirclement, and release by purse seiners affects reproduction or population growth rates in ways other than directly observed mortality. Since these effects are related to how often a
given dolphin is likely to interact with the fishery and the fishery is more likely to target large schools that carry large amounts of tuna, it is imperative to understand how schools of pelagic dolphins arrange themselves in the ETP. This study uses data from the Stenella Abundance Research Line Transect and Ecosystem (STAR-LITE) cruise from 2007 to determine if there is a non-random distribution of schools over both space and time. We model the likelihood of nearby schools being of similar or disparate sizes and estimate the range at which the correlation of school sizes is random. With this data we estimate the likelihood that a dolphin will move between schools of various sizes over a range of times. We then illustrate how these results can improve estimates of indirect effects of purse seine fishing on the recovery of these depleted populations.

Hubbs’ beaked whale revealed! Linked acoustic, genetic, and photographic data from Mesoplodon carlhubbsi
Lisa T. Ballance¹, Robert Pitman¹, Jay Barlow², Todd Pusser³, Annamaria DeAngelis⁴, Craig Hayslip⁵, Ladd Irvine⁴, Debbie Steel⁶, C. Scott Baker⁷, Daniel Gillies⁷, Jennifer Trickey⁸, Simone Baumann-Pickering⁹
¹Oregon State University, Newport, Oregon, ²unaffiliated, San Diego, CA, ³Virginia Beach, VA, ⁴NMFS/NEFSC, Woods Hole, MA, ⁵Oregon State University, Newport, OR, ⁶Fisheries and Wildlife Department and Marine Mammal Institute, Oregon State University, Newport, OR, ⁷Marine Mammal Institute, Oregon State University, Newport, OR, ⁸Scripps Institution of Oceanography, San Diego, CA, ⁹Scripps Institution of Oceanography, UCSD, La Jolla, California

Hubbs’ beaked whale (HBW, *Mesoplodon carlhubbsi*) was described from a stranding in La Jolla, California (US) in 1945. Since then, it has been known to science only from additional stranded specimens on both sides of the North Pacific (NP), and two live sightings off Oregon (US) on the same day in July 1994. On 22 September 2021, we encountered a pair of beaked whales at 45.9° N 128.6° W, approximately 200 nmi (370 km) off Oregon during a research survey focused on locating and identifying beaked whales. We first detected the whales acoustically from a towed hydrophone array, and visually located them at the surface 80 min after they stopped echolocating. We observed and photographed them during three separate surfacing sequences within a 37 min period, and from as close as 10 m. Both were subadults and a biopsy sample was required to genetically identify them as HBW. Frequency-modulated echolocation pulses recorded during the sighting matched the BW37V pulse type first described by Griffiths et al. (2019) from the California Current. Confirming the link between BW37V signals and HBW immediately extends our knowledge of this species’ at-sea distribution. Our acoustic recordings (n = 4 sites), along with previous detections of call type BW37V from free-floating Drifting Acoustic Spar Buoy Recorders (n = 22 detections) and bottom-mounted High-frequency Acoustic Recording Packages (n = 12 sites), combined with records of gillnet mortalities (n = 5) and live, at-sea sightings (n = 5) now show a broad distribution in the eastern NP in an area dominated by deep oceanic waters over abyssal plains. Although additional data will be necessary to confirm if HBW distribution is continuous across the NP, confirmation of its acoustic signature now allows for use of passive acoustic methods to clarify its distribution, relative abundance, status, and vulnerability to threats.

Effect evaluation of marine vibrator signals on blue whale vocalizations
Johannes Baltzer¹, Takashi Iwata², Tomonari Akamatsu³, Klaus Lucke¹, Marianne Helene Rasmussen¹, Magnus Wahlberg⁵, Joseph Schnitzler⁷, Ursula Siebert⁸
Vocalization behaviour of blue whales (Balaenoptera musculus) has been studied in some populations. However, little is known about the vocalizations of blue whales occurring around Iceland and how they may be affected by anthropogenic noise. In this study we conducted acoustic measurements in Skjálfandi Bay, Northeast Iceland to investigate blue whale vocalization behaviour and potential effects of simulated marine vibrator (MV) signals on their communication. MVs are considered an alternative for seismic airguns due to a potentially reduced risk of hearing impairments and behavioural disturbance for marine mammals due to the limited frequency band. However, there are concerns regarding the masking potential, especially for low frequency cetaceans. Low frequency sounds similar to those from MVs were generated via a powerful underwater transducer. We recorded blue whale down sweeps using a GPS-linked receiver array in order to estimate source levels (SL) and other characteristics of these vocalizations, such as sound production rate, duration and frequency (minimum, maximum, centroid and peak frequency). By using these devices, we were able to correlate vocalization patterns with received sound levels before, during and after sound exposure. First results show that elevated noise had an effect on blue whale vocalization behaviour. A change in sound production rate and duration was observed as a response towards the elevated noise. Blue whale down sweeps significantly differed in frequency in the post- and exposure phase compared to the pre-exposure phase. Moreover, a decrease in frequency over the course of the experimental phases was observed. First results indicate that blue whales’ source levels and sound production rates were increased in the presence of MV signals, which is a common masking release strategy in noisy conditions.
constant survival, and capture-recapture probabilities that varied by secondary periods. Survival of marked adults was estimated at 0.99 (95% CI = 0.97-1.00). Population estimates for all adults (marked and unmarked) averaged 31 animals (SD = 13.8), and for all dolphins (all adults and calves), 41 animals (SD = 17.2). Coastal bottlenose dolphins face numerous threats including ship strikes, oil spills, conflict with recreational and industrial fisheries, other negative human interactions, biotoxins, chemicals, noise, freshwater discharge, and coastal development. Further, small populations are, in general, at increased risk due to reduced resiliency and recovery potential when exposed to such threats and to expected environmental and demographic stochasticity. These historic estimates of abundance and survival are critical for establishing a reference state and indicate a need for ongoing monitoring of the small dolphin population while the Aragua coast is still, as-of-yet relatively little-impacted by humans. Should coastal development increase (as is the global trend) and/or environmental catastrophes occur (e.g., harmful algal blooms, hurricanes, oil spills), these historic estimates will be essential for assessing impacts and guiding management and conservation interventions. Our results show year-round dolphin presence and highlight the Venezuelan coastal-oceanic landscape as an area of both future research and conservation importance.

Evaluating the risk landscape for Toxoplasma gondii exposure to Hawaiian monk seals
Stacie Robinson¹, Kim Falinski², Elizabeth VanWormer³, Karen Shapiro⁴, Albert Harting⁵, Michelle Barbieri⁶
¹NOAA, ²University of Hawaii, Water Resources Research Center, ³School of Natural Resources, University of Nebraska, Lincoln, NE, ⁴Department of Pathology, Microbiology and Immunology and One Health Institute, University of California Davis, Davis, CA, ⁵Harting Biological Consulting, Bozeman, MT, ⁶NOAA

Toxoplasmosis is a top threat to Hawaiian monk seals (Neomonachus schauinslandi) in the main Hawaiian Islands where seal habitat overlaps with substantial human and domestic cat populations. As the only hosts in which the parasite Toxoplasma gondii can complete its life cycle, cats are the sole sources contaminating the environment with infectious oocysts which can be transported into the marine environment, threatening marine mammals. To understand environmental factors influencing Hawaiian monk seal exposure to T. gondii, we examined monk seal strandings from toxoplasmosis in relationship to rainfall patterns, hydrology, and cat distribution on the island of Oahu. First, using a case-control study design, we compared mortalities due to toxoplasmosis (cases) to those from other causes (controls). We found that cases were up to 35 times more likely than controls to occur after heavy runoff events. The greatest odds ratio was observed when rainfall occurred three weeks prior to stranding, potentially indicating important timelines in the disease process. Next, we estimated the distribution of outdoor cats based on previously published surveys and documented stray cat colonies. Using a hydrological model, we mapped the expected distribution and relative magnitude of oocyst runoff for Oahu’s watersheds. The model predicted that household-associated cats were greater in number and contributed an order of magnitude more oocysts to runoff than feral cats away from human settlement. There was only weak correlation between estimated cat density and locations where monk seals stranded due to fatal toxoplasmosis, with several cases occurring adjacent to watersheds with lower predicted oocyst runoff. Together these results suggest that even in areas with moderate to low densities of outdoor cats, frequent rainfall delivers sufficient numbers of oocysts to infect Hawaiian monk seals. With infectious doses as low as a single oocyst, any contaminated runoff constitutes a
Serious risk to Hawaii’s endangered monk seal.

**Solitary chemosensory cells in tracheal epithelium of harbor seals, Phoca vitulina**

Meghan Barboza¹, Beau Reyno², Lindsay Kashuba¹

¹Southern Connecticut State University, ²University of Connecticut, Storrs, Connecticut

Solitary chemosensory cells (SCCs) are specialized cells of respiratory epithelium which function as part of the innate immune system. SCCs respond to bacterial infections by sensing bitter compounds given off by pathogens and triggering an inflammation response. There is also correlative evidence that these cells respond to viral infections. While SCCs have been described in many species including humans, bovines, and several species of fish, they have not been identified in pinnipeds. This project used tracheal tissue samples collected along the east coast of the United States from necropsied harbor seals, *Phoca vitulina*. Using histological methods, the tissue was stained with antibodies against SCC specific antigens including TRPM5 and α-gustducin. Cells stained positive for these antigens in several regions of the trachea. The presence of these cells in tracheal epithelium of harbor seals indicates that SCCs may play an important function in the immune response of these animals to respiratory diseases. The role of these cells is especially important to understand in pinnipeds given recent unusual mortality events associated with the avian flu and phocine distemper virus.

**Genome-Wide Data Reveal Putative Environmental Adaptation in Common Dolphins**

Andrea Barcelo¹, Jonathan Sandoval-Castillo², Chris Brauer³, Kerstin Bilgmann⁴, Guido J. Parra⁵, Luciano Beheregaray⁶, Luciana Moller⁷

¹Flinders University, Marion, Australia, ²Bedford Park, Australia, ³Flinders University, Adelaide, SA, Australia, ⁴Department of Biological Sciences, Macquarie University, Sydney, NSW, Australia, ⁵Cetacean Ecology, Behaviour and Evolution Lab, Flinders University, Bedford Park, SA, Australia, ⁶Flinders University, Bedford Park, South Australia, Australia, ⁷Flinders University, Bedford Park

High standing genomic variation in marine species may enhance prospects for long-term persistence, and this can be a result of local adaptation driven by spatial, oceanographic and geomorphological features. For marine mammals, recent advances in sequencing techniques using small representation of the genome (i.e. ddRADseq) have helped to elucidate the influence of space and environment on local adaptation. In this study, we assessed genotype-environment associations in 214 common dolphins (*Delphinus delphis*) from southern Australia (>3,000 km), with 747 out of 17,327 SNPs found to be putatively under selection. Five putatively adapted local populations were disclosed, with evidence of high standing genomic variation and connectivity across populations and bioregions. Results suggested genomic associations with current velocity, sea surface temperature, salinity, and primary productivity. Each of these environmental variables are in turn related to three main oceanographic phenomena, which likely impact on the dispersal of common dolphins: i) broad oceanic circulation patterns, ii) presence of seasonal upwellings, and iii) seasonal circulation patterns in protected coastal habitats. Moreover, results showed putative signals of selection at exonic gene regions, suggesting that local adaptation could be related to metabolic traits. This study provides initial information about putatively adaptive genomic divergence of common dolphins in southern Australia. The associations between populations and their environment can be used to help inform and assist population management in forecasting the potential capacity of the species to cope with climate change and ongoing anthropogenic
impacts.

Oceanographic drivers of Cuvier’s (Ziphius cavirostris) and Sowerby’s (Mesoplodon bidens) beaked whales acoustic occurrence along the Irish shelf edge
Cynthia Barile¹, Simon Berrow², Joanne O’Brien²
¹Galway Mayo Institute of Technology, Galway, Ireland, ²Atlantic Technological University, Galway, Ireland

Cuvier's and Sowerby's beaked whales occur year-round in offshore Irish waters, yet remain some of the most poorly understood cetaceans in the region. Considering the importance of the area for anthropogenic activities and the sensitivity of beaked whales to noise, understanding their ecology is essential to minimise potential overlaps. To this end, fixed bottom-mounted autonomous acoustic recorders were deployed at 10 stations over four recording periods spanning from May 2015 to November 2016. Acoustic data were collected over 1,934 cumulative days, for a total of 8,403 h of recordings. We used Generalised Additive Models, fitted with Generalised Estimating Equations to deal with temporal autocorrelation, to model the probability of presence of Cuvier's and Sowerby's beaked whale clicks in the area as a function of oceanographic predictors. To reflect prey availability, variables acting as proxies of primary productivity and prey aggregation processes were selected. Our results demonstrated that oceanographic variables significantly influenced the occurrence of Cuvier's and Sowerby's beaked whales. Both species had different preferences, which might reflect different needs. This study represents an important step towards a better understanding of those species' ecology, and highlights the importance of adopting a multi-scale approach when considering environmental processes.

Examining distribution patterns of foraging and non-foraging sperm whales in Hawaiian waters
Yvonne Barkley¹, Taiki Sakai², Erin Oleson³, Erik Franklin⁴
¹Cooperative Institute for Marine and Atmospheric Research, Honolulu, Hawaii, ²NMFS/NOAA SWFSC, Environmental Assessment Services LLC, Newport Coast, CA, ³NOAA NMFS Pacific Islands Fisheries Science Center, Honolulu, Hawaii, ⁴Hawaii Institute of Marine Biology, University of Hawaii at Manoa, Kaneohe, HI

Sperm whales (Physeter macrocephalus) are a globally distributed, deep-diving cetacean species found in all ice-free oceans. Monitoring their abundance and distribution is essential for guiding management and conservation decisions. However, understanding sperm whale distribution and habitat use is challenging for many populations due to the significant amount of time whales spend foraging at depth. Species distribution models (SDMs) are a useful tool for examining and predicting cetacean distribution patterns. For a population occurring year-round in the Hawaiian Archipelago, we developed SDMs within a generalized additive modeling framework to study the distributions of foraging and non-foraging whale groups using both visual and towed array acoustic data. Sperm whale click types were used to differentiate group behavior, and SDMs were fitted using a suite of biologically relevant environmental variables. Overall, SDMs predicted higher densities of foraging groups in the northwestern region of the Archipelago between Lisianski Island and Pearl and Hermes Reef as well as north of the main Hawaiian Islands of Maui and Hawai‘i. Non-foraging groups were predicted to be more uniformly distributed throughout the archipelago. The variables that indicated the presence of foraging whales included temperature at 584 m depth, surface chlorophyll, and the standard deviation of sea surface height, while the only significant variable for non-foraging whales was
depth. This study contributes methods for combining visual and acoustic data into SDMs and adds to our understanding of the endangered Hawaiian sperm whale population.

**Small-Boat Surveys Combining Transects, Photo-ID, Sampling, and Entanglement Response to Inform Efforts to Gain Information About and Reduce the Risk of Entanglements of Large Whales Along the California Coast**

Doug Sandilands¹, Jennifer Tackaberry², Kathi George³, Kirsten Flynn⁴, James Fahlbusch⁵, Jack Barkowski⁶, Ryan Berger³, Julia O’Hern⁷, John Calambokidis⁸

¹Sealife Response Rehab and Research, ²Cascadia Research Collective; Center for Coastal Studies, Pacific Grove, CA, ³The Marine Mammal Center, Sausalito, CA, ⁴Cascadia Research Collective, Olympia, Washington, ⁵Stanford University, Cascadia Research Collective, Pacific Grove, CA, ⁶Moss Landing Marine Laboratory, California State University Monterey Bay, ⁷The Marine Mammal Center, Sausalito, California, ⁸Cascadia Research Collective, Olympia

Since 2014, there has been a three-fold increase in reports of large whale entanglements along the US West Coast. Reports of entanglements may under-represent the true number by an order of magnitude since entanglements are hard to detect. We report on a novel research effort funded by the California Ocean Protection Council to provide real-time information to CDFW’s Risk Assessment and Mitigation Program to reduce entanglement risk by lowering the probability of co-occurrence of large whales and fishing gear. The effort integrates small-vessel transect surveys (along the 70m and 200m contour depths), collection of population data and tagging; conducted by crews equipped, trained, and authorized to conduct entanglement responses for any entangled whales encountered. The project both helps prevent entanglements and improves our understanding of the problem of entanglement. Data includes: inshore and offshore distribution of whales, behavior of individuals (feeding vs. migration), prey types, and individual life history (including DPS for humpback whales). Collection of IDs and tail stock images to identify raw entanglement wounds, track acquisition of entanglement scars, and link whale’s life-history to entanglement records.

In fall 2020, we conducted 16 surveys on 11 days (using multiple boats conducting simultaneous line-transect, population surveys and tagging efforts) covering 1956 nm in five California Dungeness crab fishery (CDcf) management regions. We obtained 457 large whale sightings and IDs of 229 unique humpbacks. Our efforts, timed to help CDFW’s management actions, played a key role in reducing the risk of co-occurrence of whales and fishing gear by informing CDFW of whale presence (including DPS), distribution, and behavior towards their decisions on the opening of the CDcf. Data collected during the survey efforts and those planned for the spring and summer of 2021 will provide on-going information on whale populations and also provide data to validate models of whale occurrence.

**Record-breaking Mortality of Florida Manatees along the Atlantic Coast during 2020-2021**

Margaret Barlas¹, Martine de Wit², Chip Deutsch³, William Greer⁴, Amber Howell⁵, Nadia Gordon⁶, Andrew Garrett⁷, David Rotstein⁸, Leslie Ward-Geiger⁹

¹Florida Fish and Wildlife Conservation Commission, St Petersburg, FL, ²FWC-Marine Mammal Pathobiology Laboratory, St. Petersburg, Florida, ³Florida Fish and Wildlife Conservation Commission, Gainesville, FL, ⁴Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Melbourne Beach, Florida, ⁵Florida
A record number of manatee deaths have been documented along Florida’s Atlantic coast beginning in winter 2020 and this unusual mortality event is ongoing. From December 1, 2020 to March 31, 2021, 582 manatee carcasses were verified within the Atlantic population, nearly equal to the highest number ever recorded statewide during a four-month period (n=587). More than half of the carcasses (n=298) were found in Brevard County on the central-east coast and significantly elevated numbers were also reported along the southeast coast. The primary cause appears to be starvation, but the investigation into potential contributing factors is ongoing. Evaluation of temperature data shows that the winter was not sufficiently cold to result in this level of mortality. Necropsies share common findings: emaciation with substantial serous atrophy of tissue; little or no vegetation in the gastrointestinal tract in most cases; and minimal or no external signs of exposure to cold. About 40% of carcasses were adults, which is unusually high. Histological findings were remarkable in the extent of organ atrophy, thereby underscoring the severity of poor health of these manatees prior to death. Concurrently, a higher-than-expected number of manatees was rescued during this time, pushing rehabilitation facilities to capacity. Since 2011, long-lasting phytoplankton blooms have plagued the Indian River Lagoon (IRL) in central-east Florida resulting in significant seagrass loss. Consequences of this loss for manatees extend well beyond the IRL. We hypothesize that many manatees migrated south in a malnourished state and died in southeast Florida during winter. As manatees disperse from winter habitat with warming weather, carcasses in similar poor condition with organ atrophy have been found in northeast Florida. The full impacts of this mortality event on the Atlantic population are currently unknown, but this highlights the significant threat that loss of forage habitat presents to this threatened species.

Acoustic detections of beaked whale FM-pulses, narrow-band high-frequency pulses and other cetacean sounds in the Southern Ocean using an autonomous towed hydrophone recorder

Jay Barlow¹, Ted Cheeseman², Jennifer Trickey³
¹unaffiliated, San Diego, CA, ²Southern Cross University, ³Scripps Institution of Oceanography, San Diego, CA

A Soundtrap ST300HF hydrophone recording system in a streamlined, flooded towbody was towed on expeditionary trips to South Georgia Island and the South Sandwich Islands and to the Antarctic Peninsula in December 2019 - February 2020. High-frequency recordings (576 kHz sample rate) were analyzed to identify acoustic detections of cetacean species. Acoustically identified species included sperm whales (*Physeter macrocephalus*, n=1), southern bottlenose whales (*Hyperoodon planifrons*, n=11), Arnoux’s beaked whales (*Berardius arnuxii*, n=2), killer whales (*Orcinus orca*, n=4), and long-finned pilot whales (*Globicephala melas*, n=3). Acoustic detection also included two recognized types of beaked whale echolocation pulses (BW37/39 and BW58) as well as two beaked-whale-like echolocation pulse types that do not match any previous descriptions. Our BW37/39 pulses were intermediate in peak frequency and inter-pulse-interval to the previously described BW37 and BW39 pulse types, which are likely to be produced by the same species. Narrow-band high-frequency echolocation signals (NBHF) (typical of porpoises, *Kogia* spp. and some
dolphin species) were detected in many locations (n=30), and one of these coincided with a sighting of hourglass dolphins (*Lagenorhynchus cruciger*). NBHF detection events had peak frequencies from 122 to 131 kHz. This study shows the utility of a simple towed hydrophone system on a vessel of opportunity to study the distribution of cetaceans in rough seas that are difficult to study by visual survey methods. Surveys using a combination of visual and high-frequency acoustic methods are needed to link acoustic signals with their source species and to thereby improve passive acoustic studies of species distributions in the Southern Ocean.

**Looking back to predict the future: Dynamic models forecast blue whale distribution in a coastal upwelling system**

**Dawn Barlow**¹, Holger Klinck², Dimitri Ponirakis³, Christina Garvey⁴, Leigh Torres⁵  
¹Marine Mammal Institute, Oregon State University, Newport, OR, ²Cornell University, Ithaca, New York, ³Center for Conservation Bioacoustics, Cornell Lab of Ornithology, Cornell University, ⁴University of Maryland, College Park, ⁵Marine Mammal Institute, Oregon State University, Newport, Oregon

In dynamic marine ecosystems, the ability to forecast species distribution patterns can inform effective management. In the South Taranaki Bight (STB) of New Zealand, coastal upwelling supports an important foraging ground for blue whales in an area where anthropogenic activities also persist. Wind is the physical forcing mechanism in coastal upwelling systems, however lags between wind input and biological responses are seldom quantified or incorporated into predictive species distribution models, which could enable forecasting capability. We examined lags between wind at the upwelling source, decreased temperatures along the upwelling plume’s trajectory, and blue whale occurrence. Wind speed and sea surface temperature (SST) were extracted between 2009-2019. A hydrophone recorded blue whale vocalizations October 2016-March 2017. We conducted timeseries cross-correlation analyses between wind, SST along the upwelling plume, and blue whale D call vocalizations. Results document increasing lag times (0-2 weeks) between wind speed and SST consistent with the spatial progression of the upwelling plume, culminating with increased D calls at the distal end of the plume three weeks after increased wind at the upwelling source. These findings on physical-biological coupling were harnessed to forecast SST and net primary productivity (NPP), which are documented drivers of blue whale distribution in the STB. Boosted regression tree models skillfully predicted SST (CV deviance=0.970-0.969) and NPP (CV deviance=0.738-0.824) with 1-3 weeks lead time, depending on lags determined by upwelling dynamics. We incorporate these environmental forecasts into blue whale distribution models to effectively predict blue whale habitat on a daily scale (AUC=0.88). Suitable habitat frequently overlapped with industrial activities, yet the location and extent of blue whale habitat varied, indicating the system is well-suited for dynamic management, which could minimize both threats to whales and potential restrictions to user groups. Our forecasting models are operationalized to enhance conservation management of blue whales in the STB.

**The vocal behaviour of sperm whales in northwest Madagascar**

**Stephanie Barnicoat**¹, Chris Pierpoint², Lorenzo Scala¹  
¹Seiche Ltd., Bradworthy, Devon, United Kingdom, ²Seiche Ltd., Bioscience Group, Devon, United Kingdom

A variety of sperm whale vocalisations were recorded during long-term passive acoustic monitoring using autonomous recorder units (ARUs) at two locations of the continental shelf edge in NW Madagascar, between August 2019
and July 2020. There was a relatively high occurrence of sperm whales: at the northern site, sperm whale vocalisations were present in 28% of 15-min sound files, and 18% at the southern site. Usual click trains, with an inter-click-interval (ICI) approximately 0.5-2 s, was the most common vocalisation type recorded. Creaks with a rapid and often accelerating click repetition rate, were identified followed usual click trains (‘foraging creaks’) and in bouts (‘coda-creaks’). Bouts of resonant slow clicks were present, with ICI from 4-10 s. Codas were recorded, but occurred in only a small proportion (<1%) of 15-min sound files with sperm whale vocalisations. A tonal sound referred to as a ‘trumpet’ (Gordon, 1987) was relatively common, and was followed by usual clicks after periods of 2 to 24 s. This survey provides baseline information on the seasonal occurrence and acoustic behaviour of sperm whales in NW Madagascar.

Establishing Chronological and Biological Epigenetic Aging in Bottlenose Dolphins (Tursiops truncatus) Towards an Understanding of Cumulative Environmental Stressors

Ashley Barratclough1, Ryan Takeshita2, Forrest Gomez3, Cynthia Smith1, Abby McClain4, Celeste Parry5, Steve Horvath5, Lorelei Schwacke6
1National Marine Mammal Foundation, San Diego, California, 2National Marine Mammal Foundation, Boulder, CO, 3National Marine Mammal Foundation, 4The Marine Mammal Center, Sausalito, CA, 5David Geffen School of Medicine, University of California Los Angeles, Gonda Research Center, Los Angeles, CA

Age determination of wild cetaceans influences interpretation of both veterinary health assessments and biological data. Current aging methodologies in bottlenose dolphins (Tursiops truncatus) require physical examinations or post-mortem evaluations. Epigenetics enables DNA methylation analysis of skin, which can be remotely sampled, to provide a chronological age estimate. The capacity for remote age estimation will improve conservation efforts, particularly in large cetaceans, with increased knowledge regarding population demographics. The epigenetic clock was created utilizing samples from 33 U.S. Navy Marine Mammal Program dolphins of known age from 8 months - 57 years. 86 buffy coat and 10 skin samples were included to ensure multi-tissue application. Repeat samples from the same individuals allowed the changes in DNA over a defined time frame, to be examined to identify methylated sites associated with biological aging. Complete medical, nutritional and environmental history on each dolphin allows identification of biological age changes and the presence or absence of age acceleration.

DNA extraction was performed using the DNeasy Blood and Tissue Kit. Bisulfite conversion was performed using a Zymo EZ DNA Methylation Kit. DNA methylation was performed using a custom mammalian methylation array (HorvathMammalMethylChip40) with 37,491 oligonucleotide probes assembled. The multivariate predictor of age was developed using elastic net regression which identified 48 covariates (cytosine-phosphate-guanines, CpGs) for the blood clock (R = 0.98) and 44 CpGs for the multi-tissue clock (R = 0.96). This diagnostic tool is currently being applied to wild dolphins from different geographical locations to assess the effects of environmental stressors on biological aging.

Behavior-specific habitat use of belugas in the St. Lawrence Estuary

Emmanuelle Barreau1, Veronique Lesage2, Robert Michaud3, Clément Chion4, Tyler Bonnell3, Sebastien Lemieux-Lefebvre3, Angélique Dupuch6
1University of Quebec in Outaouai, Québec, 2Fisheries and Oceans Canada, Mont Joli, Quebec, 3Group of Research and Education on
Habitat selection and space use are important components of animal behavior that influence fitness and population dynamics. Understanding the relative importance of different habitats for fulfilling critical needs is essential for implementing effective conservation measures. Such knowledge is particularly crucial for endangered and declining populations such as St. Lawrence Estuary Beluga (*Delphinapterus leucas*, SLEB). In this study, we attempt to characterize the functions of areas of high residency that have been previously identified for this population, and to validate that sectors presumed to allow for habitat connectivity are indeed used as transit corridors. Specifically, we used a database of over 4,000 SLEB herd focal follows conducted between 1991 and 2020, and a previously established behavior classification scheme linking herd surface behavior to individual underwater activities such as foraging, traveling, socializing or resting (Lemieux-Lefebvre et al. 2018) to conduct a spatially-explicit analysis of the relative occurrence of these different behaviors, and attribute biological functions to the different habitats. A hierarchical clustering analysis of behavior relative occurrences confirmed that habitat patches identified as potential transit corridors were indeed those containing a majority of exploratory and traveling behaviors over other behaviors, relatively to areas of high residency. Generally, foraging and socializing behaviors occurred more often inside than outside high residency areas. It is noteworthy that socialization was associated with only a few sectors in contrast to foraging, suggesting that only a few habitat patches may provide features to support this particular behavior. These results are important, not only because they provide the basis for identifying habitat features underlying associated critical functions, but also because they emphasize the limited alternatives such small populations may have for their vital functions if local stressors such as underwater noise, one of the main threats to the SLEB recovery, degrade habitat quality or reduce accessibility to specific habitats.

Aquatic animals may be susceptible to a wide range of emerging diseases, potentially changing the health of individual animals and their populations. A variety of analytical approaches have been used to assess both environmental and marine vertebrate populations' health. Necropsies of marine mammals are part of a large-scale beach monitoring project underway since 2015 on the southern and southeastern Brazilian coast. This project is part of the federal environmental licensing conducted by the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) for PETROBRAS, the largest oil company operating in the Santos Basin. A large number of necropsies performed and recorded in a standardized manner allowed us to evaluate the use of a numerical index that integrates information assessed macroscopically during the necropsy and through histopathological analysis. The HIMaM (Health Index for Marine Mammals) has a theoretical range from 0 (severely compromised animal) to 1 (no systems affected) but using real data from necropsies of cetaceans (n=215) and pinnipeds (n=106), it ranged from 0.33 to 0.81. The values for cetaceans (x=0.727; SD = 0.008; median=0.750) and pinnipeds (x=0.730; SD =
Examining the variation in values of HIMaM's eight components showed a consistent pattern, indicating that they vary together with the overall index. HIMaM has proved to be efficient to analyze data generated by the institutions participating in the stranding project. It allowed us to integrate textual data generated by the project's veterinarians into a single numerical value. This, in turn, allowed to identify areas along the coast where marine mammal's health was more compromised. We believe that HIMaM can become an important tool to objectively compare marine mammal's health between areas and evaluate changes over time.

**Determining the Effectiveness of Utilizing Physical Barriers to Deter Manatee Use of Suboptimal Industrial Warm Water Sites: A Case Study Before and After Barrier**

Nicole Bartlett¹, Monica Ross², John Weishampel²

¹Clearwater Marine Aquarium Research Institute, ²Clearwater Marine Aquarium Research Institute, Green Cove Springs, Florida

Florida manatees (*Trichechus manatus latirostris*) seek warmer waters when seasonal temperatures decrease, often utilizing suboptimal warm water sites for short durations before continuing to more sustainable warmer waters. Some manatees attempt to use suboptimal sites for longer periods, yet these areas lack adequate water temperatures for long-term use and survivability. Consequently, mortality can occur or individuals may require rescue or relocation to suitable warm water. In an effort to reduce manatee use of suboptimal warm water sites, physical barriers approved by USFWS were erected at two warm water sites, District II Wastewater Treatment Facility (D2) and the Northside Generating Station (NGS), operated by Jacksonville Energy Authority on the St. Johns River in Jacksonville, Florida. Clearwater Marine Aquarium Research Institute (formally Sea to Shore Alliance) monitored the D2 discharge outfall throughout the fall and winter months from October 2010 through April 2018 at a minimum of three times a week to document the number of unique individuals utilizing the site, duration of use per individual, size class, and to report any health or behavioral concerns. Monitoring at NGS began during January 2012, with seasonal surveys conducted from November 2013 through March 2021. A barrier fence was installed in November 2014 around the D2 outfall to prohibit direct access by manatees to the warm water discharge. Fencing was installed at NGS during October 2016 to prohibit direct manatee access to an adjacent canal which maintained higher than ambient temperatures. Coaction of all partners resulted in substantially reducing the number of manatees attempting to utilize either site as a long-term solution for warm water requirements.

**Do Florida Manatees Have Wingmen? Group Composition of Manatee (*Trichechus manatus latirostris*) Mating Herds in Sarasota, FL**

Sheri Barton¹, Jennifer Johnson², Kerri Scolardi³, Christina Nau¹

¹Mote Marine Laboratory, Sarasota, FL, ²Mote Marine Laboratory, Sarasota, ³Mote Marine Laboratory, Sarasota, Florida

Florida manatees have a promiscuous mating system, scramble competition, are likely sperm competitors, and have seasonal (non-winter) peaks in breeding. Mating herds develop as a single female in estrus is pursued by a consort of up to 20+ males for periods of one month or more. Scientists and managers have had this general understanding of mating behavior in Florida manatees for some time, however critical questions remain. Our objective was to further lay the foundation toward answering the following questions regarding the males in mating herds: 1) do males within a consort
actively compete or simply jostle for position and
2) do males ever cooperate with one
another? Mote Marine Laboratory has been
documenting manatee mating herds for over 25
years during photo-identification surveys within
non-winter months in Sarasota Bay,
FL. Sightings of distinctive males (confirmed or
presumed) that were photo-documented in
mating herds were used to update our previous
analyses of group composition within and among
manatee mating herds. Although more than half
of the males were documented in a mating herd
just once, at least 24 individuals were
documented ≥15 times, with one individual
sighted over 40 times. Additionally, it is not
uncommon for males to be documented with ≥2
estrous females within a particular year.

Quantifying Florida manatee sublethal
watercraft strikes through well-healed scars
Brandon Bassett¹, Jeffrey Hostetler², Brittany
Barbeau³, Leslie Ward-Geiger⁴, Anna Panike⁴,
Gina Lonati⁵, Allison Honaker⁶, Colin Shea³
¹Florida Fish and Wildlife Conservation
Commission, ²United States Fish and Wildlife
Service, Laurel, MD, ³Florida Fish and Wildlife
Conservation Commission, St Petersburg,
Florida, ⁴FWC Fish & Wildlife Research
Institute, St. Petersburg, Florida, ⁵University of
New Brunswick Saint John, Franklin Lakes, NJ,
⁶Florida Fish and Wildlife Conservation
Commission, St. Petersburg, Florida

The Florida manatee, Trichechus manatus
latirostris, shares Florida’s waterways with
hundreds of thousands of watercraft each year.
Watercraft collisions are a leading human-related
threat that has accounted for 20-25% of reported
mortalities. Manatee-watercraft interactions can
also inflict sublethal injuries, often resulting in
fresh external wounds that present in a variety of
patterns. These wounds will eventually resolve
into well-healed scars. While scars have been
used in photo identification programs, sublethal
manatee-watercraft interactions have not been
previously quantified on a large scale. We
standardized the scar pattern identification
process based on the appearance of the 3 most
common types of lethal watercraft-related
wounds observed in carcasses. Using information
collected from carcasses recovered between 2007 –
2016, we quantified scar patterns (1 pattern = 1
strike event) on 2,935 non-perinatal carcasses
(>150 cm total length) and compared the number
of patterns by life stage, sex, population region,
as well as across years. We used generalized
linear mixed models which indicated that
approximately 96% of adults, 70% of subadults,
and 34% of calves had watercraft-related scars.
The raw data showed that 1 in 4 adults had been
hit 10 or more times; 5 adult carcasses bore
evidence of 40 or more strikes. On average, adult
females had more scar patterns than did adult
males. Manatee carcasses on Florida’s west coast
had more scar patterns than did those on the east
coast, while carcasses from the less populated
Everglades had significantly fewer scar patterns
than did those from the rest of the state. These
results improve our understanding of the extent
of sublethal injury to the Florida manatee caused
by vessel strikes. Considering these counts to be
minimum numbers, patterns indicate that vessel
collisions pose a greater risk to the health and
survival of manatees at all life stages than
previously appreciated.

Barbed! Stingray Spine Injuries to Common
Bottlenose Dolphins (Tursiops truncatus) in
Central West Florida USA
Kim Bassos-Hull¹, Gretchen Lovewell², Jessica
Blackburn³, Amber Lea Kincaid⁴, Krystan A.
Wilkinson⁵, Randall Wells⁶
¹Sarasota Dolphin Research Program/Mote
Marine Laboratory, Sarasota, Florida, ²Mote
Marine Laboratory, Sarasota, FL Florida, ³Mote
Marine Laboratory, ⁴Mote Marine Laboratory and
Aquarium, ⁵Chicago Zoological Society's
Sarasota Dolphin Research Program, Sarasota,
FL, ⁶Chicago Zoological Society's Sarasota
Dolphin Research Program, Sarasota, Florida
Stingray spine associated injuries and deaths to marine mammals have been documented in a few locations around the world. The posterior dorsal venomous spines (or barbs) of stingrays are located at mid-tail or tail insertion and used for predator defense. Bottlenose dolphins in southwest Florida share shallow coastal habitats with several stingray species and occasionally have been observed interacting with them (e.g., tossing the stingrays with their mouths). Since 1984, a portion of the dolphins in Sarasota Bay, Florida are handled periodically by the Chicago Zoological Society’s Sarasota Dolphin Research Program (SDRP) for health assessment (including evaluation of wounds). In addition, Mote Marine Laboratory’s Stranding Investigations Program (SIP) recovers dolphin carcasses in the central west coast region of Florida and examines carcasses for injuries, takes samples for pathology and determines cause of death (COD). Three hundred and two dolphins were evaluated from 1984-2019 during SDRP health assessments for presence of stingray spines or wounds potentially related to stingray spine punctures. Of these, a minimum of 31 individuals had wounds from stingray spines (nine confirmed and 22 likely). Of 20 dolphin carcasses from the Sarasota Bay resident community evaluated by Mote’s SIP with stingray spines present in body cavity or in the skeletal frame, stingray spine injury was determined to be COD in 11 cases. Stingray spines were found in the spinal canal, aorta, heart, lungs, liver, muscle, and stomach. It is likely that some of the injured bottlenose dolphins were barbed as part of stingray defensive behavior when dolphins encountered stingrays while swimming through shallow water (resulting in ventral wound), while cranial wounds resulted from “play” or foraging behavior. With dolphins under threat from a variety of anthropogenic and natural sources it is important to document and evaluate the specific contributions from different sources to provide perspective needed for management.

**Manatee Cognition, Psychophysics, and Conservation**

**Gordon B. Bauer¹**, Athena Rycyk¹, Roger Reep², David Mann³

¹New College of Florida, Sarasota, Florida, ²University of Florida, Gainesville, FL, ³Loggerhead Instruments, Inc., Sarasota, FL

How manatees perceive their environments, navigate, and make decisions are identified by the USFWS Florida Manatee Recovery Plan (2001) as important for understanding human impacts on their wellbeing. We present relevant data from previous and new behavioral, neuroanatomical, and wild studies to provide preliminary steps in addressing these cognitive tasks. Fundamental parameters for the senses of hearing, touch, and vision include: hearing acuity extending from low frequencies (0.25 kHz) well into the ultrasonic range (>70 kHz), relatively low critical ratios suggesting sensitive hearing in noise, good azimuthal sound localization and high temporal processing rates (600 Hz); highly sensitive active (jnd = 0.05) and passive touch (particle displacement threshold < 1 micron at low frequencies), including directional sensitivity to water flow; and modest visual acuity (~20 arc minutes), dichromatic color vision (unusual for marine mammals), and perhaps poor visual sensitivity to movement. Taking laboratory research to the field, we are investigating the role of environmental noise on manatee response to boats by mapping broadband hearing estimates onto ambient noise recorded in multiple locations, at different times of day in the manatee natural habitat; that is, we are looking at manatee sound detection under varying masking conditions in the wild. Going from the field to the laboratory, field observations indicate that taste and/or olfaction may play substantive roles in manatee communication and orientation, although neuroanatomical research suggests modest chemosensory attributes. Laboratory
psychophysical measurement can disambiguate these observations. Furthermore, new surveys of manatee researchers and boat captains are revealing unexpectedly sophisticated behavior suggesting flexible cognition, an essential tool for adapting to environmental change. Cognitive experimentation in the laboratory can look at this flexibility in depth. Future steps highlight using our understanding of cognition to inform conservation efforts. For example, can we leverage social learning to guide manatees away from undesirable habitats?

“Motherese” in Eastern Caribbean Sperm Whales (Physeter macrocephalus) Coda Communication
Courtney Baumgartner¹, Hal Whitehead², Shane Gero³, Taylor Hersh⁴
¹Dalhousie University, Halifax, NS, ²Department of Biology, Dalhousie University, Halifax, ³Aarhus University, Aarhus, Aarhus C, Denmark, ⁴Dalhousie University

Sperm whales use stereotyped patterns of clicks, called codas, for social communication. Calves acquire the coda repertoire of their cultural clan, but how they do so is unknown. One potential assistive mechanism for the acquisition of communicative repertoires is ‘motherese’, where mothers change some aspect(s) of their vocal communication when directed at their infant. This study set out to determine if codas made in mom-calf clusters differ from codas made in mom-adult clusters, which could indicate motherese is being used. Data on EC1 clan sperm whales were collected off the coast of Dominica between 2005–2020. Codas were extracted from audio recordings of two animals clusters (mom-calf and mom-adult) and were classified into types using contaminated mixture models. Analyses were conducted at two levels: combined-moms (n=13 moms, n=1323) and well-sampled subset-moms (n=4 moms, n=623). Codas were compared using three metrics: number of clicks, coda type, and within-type coda duration. General Linear Models were used to assess significance and General Linear Mixed Models were used to determine which variables best predicted duration of common coda types. For both cluster types, 5-click codas were most abundant, and the most common type was a ‘1+1+3_short’ coda, which made up nearly half of all codas used. There was some variation in coda types made in mom-calf compared to mom-adult clusters, but these patterns varied across moms. The average duration of the 1+1+3_short coda was significantly (p=9.43e-08) longer for mom-calf clusters compared to mom-adult clusters. In contrast, the ‘1+1+3_long’ and ‘1+1+3_med2’ coda types revealed no clear or statistically significant differences in duration, which could relate to the cultural significance of the different coda types. These results suggest that motherese may be at play in sperm whales, with moms potentially slowing their most frequently used coda to enhance calf vocal learning.

Description of the whistle repertoire of dolphins: Repertoire Size, Proportional Variability, Complexity Index & Eveness values across species and behaviors
Carmen Bazúa Durán, Facultad de Ciencias, UNAM, Mexico City, Mexico

Whistles are used by dolphins in the communication between individuals, to maintain contact within individuals of a herd, and to coordinate herd movements, especially during social interactions and feeding activities. In my research group we developed a new methodology to describe and compare the whistle repertoire of dolphins. It consists on first extracting the whistle contour using Matlab BELUGA, then classifying whistles into whistle types using Matlab ARTwarp to obtain the repertoire size, next classifying whistle types into four general categories (high complexity, low complexity, linear long, and linear short), and finally computing the proportional variability, the complexity index, and the eveness of the whistle
reertoire (Bazúa-Durán et al. 2013, POMA). This method has been tested with whistles from captive and wild bottlenose dolphins, *Tursiops truncatus*, from Laguna de Términos, and from wild Guiana dolphins, *Sotalia guianensis*, from Morrosquillo Gulf in Colombia and spinner dolphins, *Stenella longirostris*, from the Hawaiian Islands. Results show that this very simple method is useful to describe and compare the whistle repertoire of a dolphin species. And when the whistle repertoire is compared according to bottlenose dolphin activity (social, travel, feed, and rest), differences in these parameters according to bottlenose dolphin general behavior state are also found. It is necessary to implement new methodologies like this one to better understand how dolphins are using whistles, since acoustic communication is the most important sense in dolphin species. This is especially important in areas where dolphins are exposed to humans, and where underwater visibility is limited, like Laguna de Términos, a Marine Protected Area in Mexico, or the habitat where Guiana dolphins live [work supported by PAPIIT & PASPA -UNAM].

We got the BEAT! Epigenetic aging tools for dolphins and beyond

**Andria Beal**, Christina Toms, Jeremy Kiszka, Randall Wells, Jose Eirin-Lopez

*Florida International University, Chicago Zoological Society’s Sarasota Dolphin Research Program, Sarasota, Florida, Florida International University, North Miami, Florida*

Age is a critical parameter for the study of animals, providing information about development, behavior, environmental impacts, survival, and reproduction. However, age estimation is a huge challenge in many species due to a lack of defined physical characteristics that allow us to measure age. Marine mammals are no exception to this challenge. Without age data, important biological and conservation questions cannot be addressed, such as the relationships between age and environmental contaminant concentrations in tissues, and age-specific vital rate parameters. Using the known correlation between %DNA methylation at certain CpG sites throughout the genome for other mammals, the Bottlenose Epigenetic Aging Tool (BEAT) was developed using a well-known long-term resident community of common bottlenose dolphins in Sarasota Bay, Florida. The final multiple regression model had an $R^2$ value of 0.779 with an accuracy of +/- 4.8 years. This presentation will give background on how the BEAT was developed, discuss the ongoing efforts for improving the model, and present the first application of this tool to populations of dolphins of unknown age (Naples and Pensacola, Florida). In addition, the potential for this tool to benefit species beyond bottlenose dolphins and ways in which tools for other species can be developed will be discussed.

**Estimating Pacific walrus abundance and survival with multievent mark-recapture models**

**William Beatty**, Patrick Lemons, Jason Everett, Cara Lewis, Rebecca Taylor, Robert Lynn, Suresh Sethi, Lori Quakenbush, John Citta, Michelle Kissling, Natalia Kryukova, John Wenburg

*US Geological Survey, Alaska Science Center, USGS, Alaska Dept. Fish and Game, Fairbanks, Alaska, Alaska Department of Fish and Game, Fairbanks, Alaska, US Fish and Wildlife Service, Pacific Geographical Institute, Kamchatka Branch FEB RAS, Petropavlovsk-Kamchatsky, Russia*

Artic ecosystems are experiencing rapid physical and biological change, and sea ice extent and volume are two of the physical properties that are changing at a rapid pace. Sea ice loss will impact many species through altered spatial and temporal availability of resources. In the Bering and Chukchi seas, the Pacific walrus (*Odobenus*
*rosmarus divergens*) is one species that could be impacted by rapid environmental change, and thus, population assessments are needed to monitor changes in the status of this ecologically and culturally important marine mammal. We conducted a five-year genetic mark-recapture study to generate demographic estimates for the Pacific walrus. We developed a Bayesian multievent mark-recapture model to estimate walrus survival and abundance while accounting for age misclassification. We estimated probability of juvenile and adult female annual survival as 0.62 (95% Credible Interval [CrI]: 0.36–0.89) and 0.91 (95% CrI: 0.79–1.00), respectively. We estimated total abundance as 248,833 with a 95% CrI of 160,507–354,047. We provide the first estimates of Pacific walrus abundance since an aerial survey in 2006, which generated a relatively imprecise total population estimate (129,000; 95% CI: 55,000–507,000). The emerging ecosystem state in the northern Bering and Chukchi seas will likely result in a decline in Pacific walrus abundance, but there is substantial uncertainty regarding the magnitude of the anticipated decline. Our demographic estimates provide critical information to evaluate future population trends of this valuable subsistence resource.

Dynamic Habitat Models for Cetaceans Off Western Baja California, México, Provide Ecological Insight and Serve as Important Conservation Management Tools

Elizabeth Becker1, Karin Forney2, David Miller3, Jay Barlow4, Lorenzo Rojas-Bracho5, Jorge Urban6, Jeff Moore7

1Southwest Fisheries Science Center, Santa Barbara, California, 2NOAA, NMFS, Southwest Fisheries Science Center, Moss Landing, California, 3University of St Andrews, St Andrews, United Kingdom, 4unaffiliated, San Diego, CA, 5Ocean Wise, Ensenada, Baja California, Mexico, 6Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico, 7NOAA - SW Fisheries Science Ctr, La Jolla,

Management of cetaceans is typically done within national or jurisdictional boundaries that may not align with ecologically meaningful ranges for the species of interest. Many species found off the U.S. West Coast are known to have continuous distributions into Mexican waters, with highly variable abundance within the U.S. portion of their range. This has contributed to variability in design-based abundance estimates from systematic shipboard surveys off the U.S. West Coast, particularly for the abundance of warm temperate species such as striped dolphin, *Stenella coeruleoalba*, which increases off California during warm-water conditions and decreases during cool-water conditions. Species distribution models (SDMs) accurately describe shifts in cetacean distribution caused by changing environmental conditions, and are increasingly used for marine species management. However, until recently, data from waters off the Baja California peninsula, México, have not been available for modeling U.S. West Coast species ranges. In this study, we combined data from 1992-2018 NOAA shipboard surveys to develop SDMs off the Pacific Coast of Baja California for ten taxonomically diverse cetaceans. We used a well-established Generalized Additive Modeling framework to develop SDMs based on line-transect surveys and dynamic habitat variables from the Hybrid Coordinate Ocean Model (HYCOM). Models were developed for the following species with sufficient sample sizes: long- and short-beaked common dolphins (*Delphinus spp.*), Risso’s dolphin (*Grampus griseus*), Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), striped dolphin, *Stenella coeruleoalba*, common bottlenose dolphin (*Tursiops truncatus*), sperm whale (*Physeter macrocephalus*), blue whale (*Balaenoptera physalus*), and humpback whale (*Megaptera novaeangliae*). The SDMs provide the first fine-scale (10 x 10 km grid) estimates of average species density and abundance, including spatially-explicit measures of uncertainty, for
waters off Baja California. Results provide novel insights into cetacean ecology in this region as well as quantitative spatial data for the assessment and mitigation of anthropogenic impacts.

Population Distribution and Drivers of Habitat Use for Burrunan Dolphins (Tursiops australis) in Port Phillip Bay, Victoria, Australia

Jemima Beddoe1, Kate Robb2, Jeff Shimeta3
1RMIT, Australia, 2Marine Mammal Foundation, Mentone, Victoria, Australia, 3RMIT University, Melbourne, Victoria, Australia

The Burrunan dolphin, *Tursiops australis*, is a recently described species endemic to southern Australia. Port Phillip Bay (PPB), Victoria, is home to approximately 150 individuals, with an effective population size of 81.5 animals. The Burrunan population is at an increased risk of decline and/or extinction and are listed as ‘Critically Endangered’ under the Victoria *Flora and Fauna Guarantee Act 1988*. This small and genetically distinct population is susceptible to numerous anthropogenic threats including shipping, recreational boating, fishing, tourism, noise, and contaminants. The Burrunan population is thought to show high site fidelity to southern regions of PPB, however little is known about the distribution, movement patterns, home range, and habitats of significance across the entirety of PPB’s 1,930 km². To this end, 99 boat-based surveys were conducted during 2015-2019, encompassing 149 sightings and 42 focal follows were conducted throughout 2018-2019. We document the dolphin’s distribution across four different zones representative of the entire PPB and assess seasonal and annual variations of distribution via geospatial mapping. These habitat hotspots were then overlain with known biotypes within PPB to provide possible reasoning for why certain behaviours may be being displayed within a certain region. Finally, overlap between core habitats and current Marine Protected Areas were made to see if the location of conservation efforts were being used effectively for the population. This increased understanding of the vital habitat of the Burrunan dolphin population will have important consequences for future research and management plans, and effective marine mammal protected areas across Port Phillip Bay.

Body Size and Abundance of Northern Elephant Seals Using Thermal Imaging Drones

Jean-Marc Beddow1, Roxanne Beltran2, Daniel Costa3, Patrick Robinson3, Abram Fleishman4
1UC Santa Cruz, Corte Madera, CA, 2University of California Santa Cruz, Felton, CA, 3Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, 4Conservation Metrics

Tracking the abundance, distribution, and body size of marine mammals is constrained by logistical challenges, including remote, rugged terrain. For semi-aquatic animals like pinnipeds, life history events on land promote accessibility for researchers. Drones have provided a promising alternative to traditional methods, but thermal imaging drones have been limited. We used a DJI Matrice 210 commercial drone with thermal camera payload to assess RGB imaging and thermal imaging accuracy and determine the abundance, distribution, and body size of northern elephant seals (*Mirounga angustirostris*) at Año Nuevo Reserve in central California. We used a pre-programmed transect flight pattern to obtain images bi-weekly for a year, then outlined the 2,105 seals using the Computer Vision Annotation Tool and quantified each seal’s polygon area using R. We found that during the breeding season, there was a trimodal distribution of body size representing pups, adult females, and adult males. The largest average body size occurred after pups had weaned and departed for sea, and when adult females returned to molt. We found that thermal images
were superior for detecting these endothermic animals on the cold sand compared to RGB images in which seals blend in with the sand. Total seal abundance was higher during the molting than the breeding season, and seals were closer together. However, there was a slight difference between the RGB and the thermal imaging data, with thermal imaging results displaying a higher average body size area probably due to lower resolution photos. The thermal imaging data will be further assessed to quantify heat loss based on sex, size, and season and develop automated detection algorithms.

On the feasibility of crowdsourcing baleen whale vocalizations

**Julie Beesau¹, Maëlle Torterotot², Cedric Courson³, Julie Saidlitz³, Paul Nguyen Hong Duc⁴, Flore Samaran⁵, Dorian Cazau⁶**

¹ENSTA Bretagne, Brest, France, ²ENSTA Bretagne, Brest, Bretagne, France, ³Astrolabe expeditions, France, ⁴School of Mathematics and Statistics, Carleton University, Ottawa, Canada, France, ⁵ENSTA Bretagne, ⁶ENSTA Bretagne, France

Automated detection and classification of marine mammal calls is a hot topic in the bioacoustics field. However, automated methods often require large database of annotated calls, whether to train the algorithms or to validate their performance. As of today, the most common way to build these ground truth databases is by using manual annotation. This task requires time and human effort that the research teams often lack. To reduce the annotation endeavor, we set up a proof-of-concept collaborative annotation campaign in cooperation with the Astrolabe expedition non-profit organization. This organization’s mission is to create and set up participatory ocean science programs. 47 volunteer and novice participants used the web-based annotation platform APLOSE to annotate a low-frequency dataset recorded in March 2019 in the Indian Ocean. The signal was downsampled at 480 Hz so that only baleen whale calls were included in the data. Participants had one month to visualize 103 10-minute spectrograms and were asked to annotate D-calls and second unit of Australian pygmy blue whale calls. We presented the annotation task before launching the annotation campaign, and the volunteers always had access to material that described the annotation task. We were also constantly in touch via a Slack channel. The first aim of this project was to measure the motivation of the participants by monitoring their annotation progression and by sending a survey at the end of the campaign. The second aim of the project was to quantify the reliability of the annotation by comparing their annotations with those of an expert. We will present the results of this first collaborative annotation campaign and discuss the feasibility of setting up more similar initiatives to dispatch more annotation tasks to a non-expert audience.

Connecting the Public to Marine Mammals, Research, and Conservation During a Pandemic

**Noelle Belden¹, Linda Erb¹, Kimberly Browne¹, Jesse Fox¹**

¹Dolphin Research Center

It becomes increasingly critical for the public to be engaged in matters relating to marine mammal conservation. As quoted in the Alliance of Marine Mammal Parks and Aquariums Digest on April, 8th 2020, “According to a 2016 study by the World Economic Forum, eight million metric tons of plastic are dumped into the oceans every year, and that number is expected to increase.” This startling statistic, combined with a host of other threats to marine mammal populations such as over-fishing, habitat degradation, noise pollution, climate change, and the presence of toxins in the environment, create an urgent problem requiring a commitment from the public to enact behavior change. Marine mammal facilities have a long history of educational expertise connecting people with the
animals in those facilities, which translates to motivation to care for the species and the environment we share. The COVID-19 pandemic of 2020-2021 presented unprecedented challenges for marine mammal facilities to accomplish the goal of inspiration through experience. At Dolphin Research Center, we developed a number of new strategies to connect the quarantining public to marine mammals, research, and marine conservation. These strategies include: presentations through FaceBook Live, various virtual field trip programs, educator interviews with classrooms, and innovative online projects with our own Dolphin Research Center Training Institute students.

A team of educators, animal care professionals, and information technology specialists at Dolphin Research Center turned to our online resources when having visitors on site was not possible due to COVID-19 restrictions. We were able to work quickly to deliver live programs alongside our resident dolphins as well as providing curriculum-based presentations to people of all ages. Despite the vast challenges faced by the world during the COVID-19 pandemic, we were able to continue our good work and further our mission of inspiring marine mammal conservation action.

Combining Spatial and Temporal Acoustic Datasets to Examine the Summer Presence of Beaked Whale and Kogia Species Off the East Coast of the US

Annamaria DeAngelis\(^1\), Taylor Ackerknect\(^2\), Simone Baumann-Pickering\(^3\), Joel Bell\(^4\), Danielle Cholewiak\(^5\), Rebecca Cohen\(^6\), Chelsea Field\(^7\), Kait Frasier\(^8\), John Hildebrand\(^9\), Liam Mueller-Brennan\(^10\), Taiki Sakai\(^11\), Alyssa Scott\(^12\), Melissa Soldevilla\(^13\), Alba Solsona Berga\(^14\), Jennifer Trickey\(^15\), Robert Valtierra\(^16\), Sofie Van Parijs\(^17\)

\(^1\)NMFS/NEFSC, Woods Hole, MA, \(^2\)Scripps Institution of Oceanography, \(^3\)Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, \(^4\)Contractor, Northeast Fisheries Science Center, National Marine Fisheries Service, Oregon State University, East Falmouth, MA, \(^5\)NMFS/NOAA SWFSC, Environmental Assessment Services LLC, Newport Coast, CA, \(^6\)The Whale Museum, Friday Harbor, WA, \(^7\)Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL, \(^8\)Scripps Institution of Oceanography, San Diego, CA, \(^9\)Marine Acoustics Inc., Middletown, RI, \(^10\)NOAA NMFS NEFSC, Woods Hole, MA

Beaked whales (family Ziphiidae) and dwarf/pygmy sperm whales (family Kogiidae) are cryptic, deep diving cetaceans that prefer offshore habitats. As such, little is known about their global and regional distributions. Since the early 2000s, much effort has been placed in defining the acoustic characteristics of the species within these families, as both emit unique echolocation click types while foraging. Thus, passive acoustic monitoring (PAM) of these families has helped to expand the current knowledge of their behavior, distribution, and habitat use through combinations of bottom-mounted and drifting surface recorders, towed hydrophone arrays, and acoustic tags. However, very few studies have utilized these different platforms simultaneously. From 28 June – 25 August 2016, two shipboard cetacean abundance surveys were conducted by the National Oceanic and Atmospheric Administration’s Northeast and Southeast Fisheries Science Centers along the entire US eastern seaboard with towed hydrophone arrays deployed. These shipboard surveys are useful at providing a broad scale snapshot of the spatial distribution of Ziphiidae and Kogiidae species. In addition, bottom mounted recorders (HARPs), which are well-designed for capturing the temporal distributions of these families at fixed sites over time, were also collecting continuous passive acoustic data.
at 11 sites along the shelf break. Here, we combine the results of examining both the spatial and temporal distributions of these species using both types of platforms (mobile and fixed) during the time of the shipboard surveys (28 June – 25 August 2016). We also examine the depths of foraging beaked whales using surface reflections collected on the towed hydrophone arrays to look at their vertical water column distribution cross-species. This is the first study of its kind that provides a comprehensive look at how these species are utilizing a large area in three-dimensional space and time.

**Lightscapes of Fear: How Elephant Seals Balance Starvation and Predation in the Open Ocean**

Roxanne Beltran¹, Jessica Kendall-Bar², Enrico Pirotta³, Taiki Adachi⁴, Yasuhiro Naito¹, Akinori Takahashi⁵, Jolien Cremers⁷, Patrick Robinson⁸, Daniel Crocker⁹, Daniel Costa¹

¹University of California Santa Cruz, Felton, CA, ²Scripps Institution of Oceanography- Center for Marine Biotechnology & Biomedicine; UC San Diego, ³University of St Andrews, St Andrews, Scotland, United Kingdom, ⁴National Institute of Polar Research, Tachikawa, Tokyo, Japan, ⁵National Institute of Polar Research, Yokohama, ⁶National Institute of Polar Research, Tokyo, Japan, ⁷University of Copenhagen, Denmark, ⁸Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, ⁹Sonoma State University, Rohnert Park, CA

Like landscapes of fear, animals are hypothesized to strategically use lightscapes based on intrinsic motivations. However, longitudinal evidence of state-dependent risk aversion has been difficult to obtain in wild animals. Using high resolution biologgers, we continuously measured body condition, time partitioning, 3-dimensional movement, and risk exposure of 71 northern elephant seals (*Mirounga angustirostris*) throughout their 7-month foraging migrations (N=16,000 seal-days). As body condition improved from 21% to 32% fat and daylength declined from 16 to 10 hours, seals rested progressively earlier with respect to sunrise, sacrificing valuable nocturnal foraging hours to rest in the safety of darkness. Seals in superior body condition prioritized safety over energy conservation by resting >100 meters deeper where it was 300x darker. Together, these results provide empirical evidence that marine mammals actively utilize the 3-dimensional lightscape to optimize risk-reward tradeoffs based on ecological and physiological factors.

**Vessel characteristics and activities affect underwater soundscapes and elicit harbour porpoise responses prior to pile-driving at offshore windfarm sites**

Aude Benhemma-Le Gall¹, Isla Graham², Nathan Merchant³, Paul M. Thompson⁴

¹University of Aberdeen, Evanton, United Kingdom, ²University of Aberdeen, Cromarty, Ross-Shire, United Kingdom, ³Cefas, Lowestoft, United Kingdom, ⁴University of Aberdeen, Cromarty, United Kingdom

Mitigation of cumulative effects of offshore windfarm development requires understanding and quantification of effects of multiple stressors related to construction activities. While extensive research has focused on the effect of intensive piling noise on protected marine mammals, uncertainty remains over factors affecting variation in the presence of animals during preparation work at construction sites prior to piling activities. We investigated the effects of pre-piling activities on the local soundscape and harbour porpoise occurrence at the UK’s two first large-scale deep-water offshore windfarms. Arrays of echolocation click detectors (CPODs) deployed at the windfarm sites throughout the 2017 and 2019-20 piling campaigns were used to assess porpoise occurrence within a 5 km buffer around a subset of piling locations from 48 h before piling and deterrence activities. In
parallel, we characterised the levels of vessel intensity using AIS data, measured underwater broadband noise levels using calibrated noise recorders (SoundTraps), and related those with construction activities extracted from the piling vessel logbooks and engineering records. Throughout the two piling campaigns, harbour porpoise occurrence gradually declined, by up to 17-18%, from 11 h before piling. The probability of detecting porpoises in the vicinity of construction sites, one hour prior to piling and deterrence activities, varied between 10 and 20%. This decrease in detections was associated with increased levels of vessel intensity and specific activities requiring the support of ancillary vessels (e.g. running and picking-up anchors), both elevating the local soundscape. These results provide strong evidence of porpoise displacement several hours prior to piling activities, providing important context when assessing and mitigating cumulative impacts of preparation and construction work at offshore windfarm sites. Furthermore, this study can be used to inform adaptive management and improve mitigation measures e.g. to prevent far-field disturbance effect of deterrent devices.

Combining two types of acoustics devices to mitigate bottlenose dolphin depredation on purse seine in Tunisian Northeastern coasts

Rimel Bennessaud1, Mourad Cherif2, Arwa Chakroun1, Wael Kouched4
1INAT/INSTM, Tunis, Tunisia, 2Institut National des Sciences et technologies de la Mer, Tunis, Tunisia, 3INAT, Tunis, Tunisia, 4Institut National des Sciences et technologies de la Me, Tunis, Tunisia

Dolphins–fisheries depredation are a recurring problem. These interactions are a source of conflict, particularly between fishermen and those who seek to preserve cetaceans. This work is in the framework of the MAVA-Depredation project, coordinated by ACCOBMAS and CGPM, whose long-term objective is to reduce depredation by bottlenose dolphins on seines targeting small pelagics fishes while using two types of repellents: Dolphin Deterrent Device (DDD-03-H) and Dolphin interactive Device (DiD-01) which is merely the interactive version of the DDD model. The trial was conducted during the period from November 2020 to August 2021. We administered 10 acoustic devices (5 DDD-03-H/5 DiD-01) to 10 purse-seiners. Five purse–seiners, deprived of devices, participated in this study as control vessels. During this experiment, we quantified the depredation rate, the holes typology, the associated mending costs, the catch per unit effort and the effectiveness rate of the tested repellents. Depredation is evidenced by a partial or total escape of school of fish aggregated under the light deployed by purse-seiners or damage to the seines during the encircling and brailing operation.

The fishing operations carried out without devices had a higher depredation rate than those with devices (% depredation without devices = 31.42; % depredation with devices = 20.19), knowing that those equipped with DiD-01 had a lower depredation rate (% Depredation DDD-03-H= 30.15; % Depredation DiD-01=14.02). The number of holes and mending costs are also significantly lower when using devices and especially with the interactive ones. The CPUE is highest when repellents and especially DiD are used. DiD devices are more effective than DDDs (% Effectiveness DDD-03-H= 55.00; % Effectiveness DiD-01=74.77).

This study must be sustained in the long term in order to better evaluate the effectiveness of these devices and to assess the duration of habituation to each devices' emitted waves.

Blubber function in juvenile grey seals is related to moult status and tissue depth but not POP exposure: implications for life stage sensitivity and dose responses.

Kimberley Bennett1, Alexandra Tranganida2,
Metabolic function and energy balance are targets of disruption by persistent organic pollutants (POPs). Fat tissue development and function, in particular, are impacted by a range of contaminants across taxa. Blubber function in grey seal pups depends on nutritional state and tissue depth, and is altered by POP exposure, with important implications for mass gain. Juveniles experience a dramatic reduction in body fat content in their first year of life with a concomitant increase in blubber POP levels, which may make them equally vulnerable to fat function disruption. Using explants from 16 yearling grey seals we investigated whether blubber glucose uptake, lipolytic rate (glycerol production) and insulin sensitivity (Akt phosphorylation) depend on 1) moult state; 2) blubber depth; 3) POP levels in vivo and 4) overnight exposure to organochlorines. Metabolic parameters and Akt content were higher in inner compared to outer tissue. Lipolytic rate was higher in post moult animals than pre moult or moulting individuals. Akt content was higher in inner blubber of moulting animals. Glucose uptake and Akt phosphorylation in the presence or absence of insulin did not differ between moult states. There was no relationship between blubber POPs and metabolic parameters or insulin sensitivity. Measured variables were not affected by overnight organochlorines exposure. The lack of POP effects here is in marked contrast to findings in pups. Blubber function parameters and mass gain rate were lower and POP levels were higher in yearlings than in pups. Our data thus indicate that either juveniles are less susceptible than pups to POP disruption of blubber function or they experience maximal POP disruption. These possibilities cannot be teased apart with the current data, but need to be explored to establish dose responses of blubber disruption and better understand vulnerability of key life stages to POP-induced metabolic disruption in marine mammals.

Circulating Concentrations of Cortisol in Cows and Calves during Weaning in Bottlenose Dolphins (Tursiops truncatus)

Don Bergfelt1, Rocio Canales1, Maria Vences2, Meghan Smallcomb2, Roberto Sanchez-Okrucky2
1Ross University School of Veterinary Medicine, 2Dolphin Discovery, Mexico

Evaluation of temporal changes in circulating concentrations of cortisol during the weaning process in aquarium-based bottlenose dolphins (Tursiops truncatus) has fundamental and practical implications to enhance management practices. The study involved 5 cow/calf pairs where calves were 12-19 mo at weaning. Blood samples were collected voluntarily from cows and calves between 0800 and 1100 h episodically for two weeks before weaning day (Day 0) and on Days 1, 3, 5, 12, 16, 20, 31 post-weaning. Pre-weaning involved a gradual process of conditioning through positive reinforcement where cows voluntarily moved from a maternity pen to nearby pens for training while calves remained in the maternity pen with trainers. Gates between pens remained open to allow cows or calves to reunite. After 2-4 mo, weaning day was initiated and gates were closed between maternity and adjacent pens when cows and calves were separated. Immediately, cows and calves began exhibiting different types and degrees of agitated behavior (e.g., rapid and erratic swimming, side jumping, breaching,
Call for marine mammal scientists to urgently transform research and prioritise fisheries bycatch mitigation to prevent further species extinction and extirpation

Per Berggren, Newcastle University, School of Natural and Environmental Sciences, United Kingdom

Cetaceans have been threatened by gillnet fisheries bycatch for over 50 years. It was first discovered in the late 1960s, investigated in the 1980s & 90s, and a global estimate presented in 2006. Bycatch is the single greatest threat to cetaceans responsible for the extinction of the baiji dolphin and imminent extinction of the Vaquita and 12 other species, subspecies, or populations of small cetaceans and the North Atlantic right whale. Yet, there is little effort to prevent bycatch in general and by cetacean researchers. This is evident by reviewing the number of presentations at past SMM conferences focusing on bycatch assessment and mitigation. In 2015 there were 1530 presentations, 45 (2.9%) on bycatch and 5 on bycatch mitigation. In 2017 of 1275 presentations, 47 (3.7%) dealt with bycatch of which 14 bycatch mitigation. In 2019, 38 (2.3%) addressed bycatch and 3 bycatch mitigation of 1636 presentations. With only 3% of abstracts presenting bycatch research there is little evidence we make sufficient efforts to act on the threat we repeatedly state is responsible for the current conservation crisis of cetaceans. It is highly unlikely that research presented in the 97% of the presentations 2017-2019 were undertaken in coastal areas where the study animals were not threatened by fisheries bycatch. 

Action list for SMM: Demand that relevant authorities set conservation objectives by quantifying biological reference points (safe level of mortality that ensures viable population) for all cetacean species. To facilitate this, estimate abundance/population size and bycatch mortality using observers/electronic monitoring while simultaneously test best available mitigation method. Calculate total bycatch mortality and implement bycatch mitigation to ensure mortality is below reference point. 

In conclusion, we all need to transform our marine mammal research and contribute wherever we can to mitigate bycatch before we lose more species and populations on our watch.
Endangered populations of marine mammals around the world are facing multiple threats that may decrease their reproductive success and jeopardize their recovery. Therefore, it is relevant to develop new non-invasive approaches to estimate pregnancy rates in wild populations. This project aims to use overhead photos of pregnant belugas at various aquaria, taken with a camera fixed at a known height, to assess changes in the body shape of the animals throughout pregnancy. Images obtained on a weekly or fortnightly basis during the last six months of three pregnancies were used to obtain body width of the whale at 5% intervals along the total body length. Measures in pixels of the five best images per date were scaled to true size and transposed into body shape landmark data. A procrustes superimposition was performed to extract shape information, followed by a principal component analysis to explore the evolution of the body shape through gestation. Visualization of beluga’s shape information was used to identify whales’ body regions that changed the most during these periods. Our results suggest that body width measurements obtained by photogrammetry using overhead photos of aquarium belugas allow to reliably distinguish pregnant from non-pregnant belugas (84% of the variance was explained by PC1 and PC2). This approach was also able to capture the changes in body shape over the last six months of the gestation. These changes were primarily found between the end of dorsal ridge and mid-peduncle, with body width increasing through time until delivery. These first results will aid in developing methods to identify pregnancy in beluga whales in the wild using photographs taken with Unmanned Aerial Vehicles. Further analyses will be conducted to test if this approach could be used to distinguish females from males and evaluate their body condition status.

Stable isotope analysis reveals differences in domoic acid accumulation and feeding

Given the effects of harmful algal blooms on human and wildlife health, understanding how domoic acid (DA) is accumulated and transferred through food webs is critical for recognizing the most affected marine communities and predicting ecosystem effects. This study combines stable isotopes of carbon and nitrogen from bulk muscle tissue with DA measurements from viscera to identify the foraging strategies of important DA vectors and predators in Monterey Bay, CA. Tissue samples were collected from 23 species across three habitats in the summer of 2018 and 2019. Our results highlight 13C enrichment in krill and elevated DA concentrations ([DA]; ppm) in anchovies at central and southern sites in Monterey Bay, indicating inshore-offshore differences in coastal productivity and DA accumulation. The narrow overlapping isotopic niches between anchovies and sardines, and striking differences in [DA], suggests diet specialization and resource partitioning, potentially based on prey size. In contrast, krill, market squid, and juvenile rockfish accumulated minimal DA and have a lower capacity to serve as DA vectors, potentially because of variability in diet and baseline values among individuals and collection sites, which is evident by their broader isotopic niche. Low [DA] in the livers of stranded sea lions along with their large isotopic niche may indicate that individuals have different diets or feed in isotopically distinct locations, which limits our ability to use sea lions as sentinels for DA outbreaks in a specific geographic area. Finally, we compare the foraging strategy of sea
lions with other marine mammals in the California Current System to determine which species may be the best sentinel for DA events.

The Caribbean Cetacean Society, a local network breaking the islands frontiers for Cetacean conservation!

jeffrey BERNUS¹, Laura Pittino²
¹Caribbean Cetacean Society (CCS), Martinique, ²Caribbean Cetacean Society, Martinique

The Caribbean host more than a third of the world's cetacean species. These animals travel great distances, and their distribution can include several countries between which they circulate regularly. On the scale of a large cetacean, the Caribbean is a unique space that these animals have used for longer than us, with no boundaries other than environmental parameters. It is therefore up to us to adapt and work together to break down our barriers, in order to protect them despite our differences – in legislation, language and culture – in each of our territories. Organizations undertaking quality field and policy work exist on many islands, but are often isolated. Projects aimed at enhancing collaboration within the region are limited in time and funding, and an organisation led by local scientist is needed to coordinate the different actions on the long term. The Caribbean Cetacean Society (CCS) is an NGO created in order to promote and improve the conservation of cetaceans through the coordination of a network of professional, associative and institutional actors. By breaking our frontiers in this pandemic crisis we have completed gaps in cetaceans diversity and distribution knowledge. When considering larger geographical area of studies news results are completing the previous studies made on the spermwhales social distribution and population estimate. These team work, is therefore needed to improve conservation in each islands.

Modelling Human Acoustic Perception to Automatically Detect North Atlantic Right Whale Vocalizations

Wilfried A. M. Beslin¹, Oliver S. Kirsebom², Nicole Chisholm³, James A. Theriault⁴, David Flogeras⁵, Clair Evers⁶, Angelia Vanderlaan⁷
¹Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, ²Institute for Big Data Analytics, Dalhousie University, Halifax, Nova Scotia, ³Fisheries and Oceans Canada, Ottawa, Ontario, ⁴Ocean Environmental Consulting, Halifax, Nova Scotia, ⁵Fisheries and Oceans Canada, Halifax, ⁶Fisheries and Oceans Canada, Dartmouth, Nova Scotia

Passive acoustic monitoring (PAM) has become an invaluable tool for assessing cetacean presence, but the large volumes of data produced by autonomous recorders can be challenging to analyze efficiently. To overcome this problem, many PAM analysis protocols depend on some level of automatic signal detection. However, autodetectors are typically less accurate compared to human analysts, and in many cases may suffer from high false positive and/or false negative rates. One technique that humans frequently use to validate suspected cetacean calls is to listen: trained analysts are often capable of hearing differences between target and non-target sounds that otherwise look similar on a spectrogram. In light of this observation, an automatic detector simulating the human perception of sound has the potential to perform well, particularly in discriminating between sounds that are difficult to distinguish based on simple physical features alone. Previous research experimenting with this auralization approach has achieved high success rates in discriminating between various sounds, including sonar echo returns and vocalizations from different marine mammal species. The goal of this particular research is to apply auralization to automatically detect vocalizations from the critically endangered North Atlantic right whale (NARW), most notably the stereotyped “upcall”. A simple
model of the human auditory system was developed that currently extracts 51 features found to characterize timbre. The discriminative power of these psychoacoustic features for identifying NARW upcalls was explored using principal component analysis and quadratic discriminant function analysis. NARW upcall annotations derived from autonomous recorders located throughout Atlantic Canada were used for classifier training. Performance of auralization-based upcall detection was compared with that of the commonly-used Low Frequency Detection and Classification System (LFDCS). Results showed that auralization-based classification produced fewer false detections and missed calls than LFDCS, though the overall performance of both methods remains relatively low.

Site fidelity of the Saimaa ringed seal (Pusa hispida saimensis): new research perspectives
Vincent Biard¹, Milaja Nykänen¹, Marja Niemi¹, Tommi Nyman¹, Mervi Kunnasranta¹
¹University of Eastern Finland, Joensuu, Finland, ²Norwegian Institute of Bioeconomy Research, Svanvik, Norway, ³University of Eastern Finland, Joensuu, Finland

Through habitat loss or degradation, climate change and other anthropogenic activities affect pinnipeds breeding and moulting. Therefore, studying site fidelity pattern is essential for the conservation and management of these populations. We conducted photo-identification with ringed seals for more than a decade in the most densely populated parts of Lake Saimaa, Finland. We further extended the data collection to the whole distribution area in 2016-2019 by combining boat surveys and camera traps. Mark-recapture data have revealed clear pattern of strong site fidelity, corroborating previous telemetry studies. Over these four moultng seasons (end of April to mid-June), the median number of terrestrial haul-out sites used by an individual seal (N=192) was four and nearly half of them reused same sites over seasons. The median distance between moultng sites successively used by an individual seal was only 643 m. While these distances were similar within moultng seasons in both sexes, the distances between seasons were longer in females, suggesting post-nursing related behaviour. We also observed that several individuals (N=73) shared the same moultng sites. Moreover, some of these associations were repeated over the years, which may highlight some degree of social interactions. Defining the social network would provide better understanding of the behaviour of this endangered subspecies and to assess the risk of disease spreading. Although photo-identification is relevant to monitor Saimaa ringed seals during the moultng season, other approaches are needed for the rest of the year when the seals are mainly in the water. We previously used satellite tracking, but we would like to implement less invasive and larger scale applicable methods. Following lair monitoring in the end of the winter, divers inspect breeding lairs to collect placentas. Placentas have proven to be a sufficient source of DNA and could be used to study, for instance, female breeding site fidelity.

Seasonal gain in body condition of foraging humpback whales along the Western Antarctic Peninsula
KC Bierlich¹, Josh Hewitt², Robert Schick³, Julian Dale³, Ari Friedlaender⁴, Fredrik Christiansen⁵, Kate Sprogis⁶, Allison Duprey⁷, Clara Bird⁸, Gregory Larsen⁹, Jeremy Goldbogen¹⁰, Andy Read¹, David Johnston¹¹
¹Marine Mammal Institute, Oregon State University, ²Duke University, Durham, NC, ³Duke University Marine Lab, ⁴University of California Santa Cruz, Santa Cruz, California, ⁵Aarhus Institute of Advanced Studies, Aarhus, Denmark, ⁶Marine Bioacoustics Lab, Aarhus University, Australia, ⁷University of North Carolina at Chapel Hill, Durham, NC, ⁸Marine Mammal Institute, Oregon State University,
Most baleen whales use stored energy acquired on foraging grounds to finance the costs of migration and reproduction on breeding grounds. In such capital breeders, body condition reflects an individual’s foraging success and can provide information on prey availability, habitat quality, and future reproductive success, which influence population dynamics. However, little is known about how free-living baleen whales increase their body condition over the course of the foraging season. Here we use photogrammetry from drone images to examine how the body condition of humpback whales (*Megaptera novaeangliae*) (n = 228) changed over the foraging season along the Western Antarctic Peninsula (WAP) from November to June, 2017 to 2019. This population is recovering from past commercial whaling and is growing rapidly, providing an opportunity to study how whales deposit energy in a prey rich environment. We used body area index (BAI) to estimate changes in body condition and applied a Bayesian approach to incorporate measurement uncertainty associated with different drone types used for data collection. We used biopsy samples to determine sex and pregnancy status, and length-based maturity classification to assign reproductive classes. BAI increased linearly over the feeding season for each reproductive class. Lactating females had lower BAI compared to other mature whales late in the season, reflecting the high energy costs of nursing a calf. Mature males and non-pregnant females had the highest BAI overall, reflecting high energy stores required to support reproduction during the coming breeding season. Calves (n = 31) and immature whales (n = 82) also increased BAI over the feeding season, but did not increases in structural size (body length). This work establishes a baseline for how baleen whale populations increase body condition throughout the foraging season, which can help monitor future impacts of disturbance.

Individual behavioral specializations in gray whales documented through drone-based observation

Clara Bird¹, Leigh Torres²

¹Marine Mammal Institute, Oregon State University, Royal Oak, MI, ²Marine Mammal Institute, Oregon State University, Newport, Oregon

Quantifying the degree of individual behavioral specialization within a population can enable effective management, particularly regarding the degree of resource and habitat partitioning that may influence population resilience to environmental change and disturbance events. Gray whales in the Pacific Coast Feeding Group (PCFG) employ a variety of shallow water foraging tactics off the coast of Oregon, USA. Videos collected via drones provide an opportunity to observe, identify, and quantify these unique foraging tactics, link these data to individual whales through photo-identification, and examine the degree of behavioral specialization relative to individual, habitat, and time (months and years). From June through October of 2016–2020, we conducted over 400 drone flights over 133 individual PCFG whales. We developed a detailed ethogram of 5 primary and over 20 sub-behavior states to process 90 hours of drone footage where we identified specific behavior tactics employed by each individual. We link foraging tactics to individual whales and their demographic unit, benthic habitat type at the location, environmental conditions, and temporal period. We use these data to test the hypotheses that (1) the degree of individual specialization is greatest at the monthly time scale compared to longer temporal periods due to environmental variability, and (2) individual specialization is greater in times of...
low prey availability, allowing whales to maximize resource partitioning. We document foraging tactics that are both specific to individuals and used generally across the population. Next, we use the proportional similarity index to quantify how the degree of individual specialization varies across the time scales (month, year, and full study period). This study illustrates diverse behavioral specialization by individual baleen whales that are maintained across years. Such information establishes a foundation for investigating gray whale resource and space use under changing conditions, which can foster effective management of whale populations.

**Norway’s slow evolution towards a more Porpoise-Friendly Fishery Policy**

*Arne Bjørge*¹, André Moan²
¹Institute of Marine Research, Norway, Bekkestua, Akershus, Norway, ²Institute of Marine Research, University of Oslo, Moss, Østfold, Norway

Monitoring marine mammal bycatches in Norway started in 2006, after the North Atlantic Marine Mammal Commission, NAMMCO, established a working group to evaluate the extent of such bycatches. The majority of marine mammal bycatches in Norway is harbour porpoises, *Phocoena phocoena*, taken in large-mesh bottom-set gillnets. The average annual bycatch in the period 2006-2018 was 2674 porpoises. This exceeds the Potential Biological Removal of 2542 porpoises per year. Therefore, trials with pingers on gillnets were conducted in 2018-19 and yielded a 96% reduction in porpoise bycatches. About 900 porpoises were annually bycaught in the Vestfjord. The Vestfjord is the spawning ground for the worlds largest cod stock. In June 2019, an international expert workshop evaluated Norwegian bycatch monitoring and mitigation efforts and recommended that pingers should be mandatory in the Vestfjord cod fishery. This recommendation was vetted by the Norwegian Marine Mammal Scientific Advisory Board and the Institute of Marine Research’s Advisory Committee and forwarded to the Fisheries Authorities in October 2019. In the spring of 2020, the Directorate of Fisheries sent a proposal on mandatory pinger use on public hearing. The hearing revealed wide support for the pinger proposal. Arguments used in favour for mandatory pingers were to accommodate the US MMPA Import Provisions, domestic animal welfare legislation and the industry’s wish to obtain Marine Stewardship Council certification of fish products. In early autumn of 2020, the Directorate recommended mandatory pingers in Vestfjorden during the cod fishery. On the November 5th 2020 the Ministry of Fisheries decided that pingers should be mandatory on gillnets targeting cod in Vestfjorden starting January 1st 2021. The Directorate’s Sea Surveillance Unit has developed programs to monitor the compliance to the pinger regulations. Scientific monitoring of a marine mammal bycatch problem initiated in 2006 resulted in management decision to mitigate the problem in 2020.

**Preserving cetacean skeletons using wet maceration**

*Jessica Blackburn*¹, Gretchen Lovewell², Rebeccah Hazelkorn³, Ruth DeLynn⁴
¹Mote Marine Laboratory, ²Mote Marine Laboratory, Sarasota, FL Florida, ³NOAA, National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, Florida, ⁴Mote Marine Laboratory, Sarasota, Florida

Preserving the complete skeleton of a cetacean following thorough necropsy helps obtain further information on life history, injuries, and/or disease processes. Well curated collections allow for comparisons of skeletons to provide evidence of morphological differences within and/or between species. Skeletal material, coupled with genetic analysis, is crucial in the
taxonomy of cetaceans. The American Society of Mammalogists accredited Ruth Delynn Cetacean Osteological Collection at Mote Marine Laboratory catalogues cetacean skeletons recovered or acquired through Mote’s Stranding Investigations Program, providing a specimen library for researchers worldwide. The bones in this collection are processed via wet maceration; however, there is a general lack of published information regarding this technique. Wet maceration for cetacean skeleton preservation can be scaled depending on space availability and the size of the cetacean. An outdoor, uncovered area at least 25m² is ideal, with access to electricity and fresh running water. Each specimen is placed in a 32-gallon barrel (minimum recommended size) and fitted with a water aerator. Smaller cetaceans may fit in one barrel, while larger cetaceans may require multiple. A high-pressure hose or nozzle to wash the bones once macerated, along with movable drying racks to be positioned under direct sunlight, allow for cleaned, sun-bleached bones to be available for further examination. Depending on the degree of flensing, carcass size/species, frequency of water changes, and air temperature, this process can be completed in as little as one month. Colder weather can prolong this process by slowing down the growth rate of bacteria that eats away at the flesh inside the barrel. Wet maceration of cetacean species is a relatively quick, contained, cost-efficient and effective process that can provide insight into causation of individual strandings, as well as evidence to make taxonomic decisions regarding species, when strengthened by large numbers of specimens.

Estimation of acoustic cue rates in bowhead whales, Balaena mysticetus, during the fall migration

Susanna Blackwell¹, Aaron Thode², Alexander S. Conrad³, Megan Ferguson⁴, Catherine Berchok⁵, Kate Stafford⁶, Tiago Marques⁷, Katherine Kim⁸

¹Greeneridge Sciences, Inc., Aptos, California, ²Scripps Institution of Oceanography, La Jolla, CA, ³Greeneridge Sciences Inc., Santa Barbara, California, ⁴Alaska Fisheries Science Center/NOAA, Seattle, WA, ⁵Marine Mammal Laboratory, Seattle, WA, ⁶University of Washington, Seattle, Washington, ⁷University of St Andrews, ⁸Greeneridge Sciences, Inc., Santa Barbara, CA

Cue rates, i.e., the number of calls made per individual per hour, were estimated for Bering-Chukchi-Beaufort bowhead whales (Balaena mysticetus) during their autumn migration along the North Slope of Alaska. Knowledge about cue rates is important because they are necessary to convert between passive acoustic data and whale density estimations. Calls detected on directional acoustic recorders (DASARs) over eight years (2007–2014) in the Beaufort Sea were triangulated to provide call location estimates at five recorder arrays placed in the whale migration corridor; these call counts were then translated into call densities (calls / hour / km²). ASAMM aerial survey data were used to estimate the fraction of the migration corridor missed by the arrays, while year-round passive acoustic data obtained independently were used to estimate the fraction of the seasonal migration missed because recorders were retrieved before the end of the migration. This information was combined with population size estimates from independent spring counts and travel speed estimates. Using various assumptions regarding the variables described above, 351 cue rate estimates were obtained, which summarized to a median of 1.3 calls / whale / h with an interquartile range of 0.5–5.4 calls / whale / h. This analysis showed that despite uncertainties in our assumptions, bowhead cue rates during the autumn migration could be bounded to within a relatively narrow range, with 80% of the estimates between 0.3 and 14.5 calls / whale / h. In addition, there was generally good agreement between estimates obtained in different years and different array locations.
Diving in a dish: Novel cell culture models pinpoint molecular adaptations of marine mammals

Ashley Blawas¹, Kathryn Ware², Emma Schmaltz², Larry Zheng⁴, Alexandra Reph², Austin Allen⁵, Nicole West⁶, Nicolas Devos⁷, David Corcoran⁷, Doug Nowacek⁸, William Eward⁹, Andreas Fahlman¹⁰, Jason Somarelli⁹

¹Duke University, ²Department of Medicine, Duke University Medical Center, Durham, NC, ³Duke University Marine Laboratory, Beaufort, North Carolina, ⁴Duke University, Durham, NC, ⁵Duke University Marine Lab, ⁶Dolphin Quest Oahu, Honolulu, Hawaii, ⁷Duke Center for Genomic and Computational Biology, Duke University, Durham, NC, ⁸Duke University, Beaufort, North Carolina, ⁹Duke University Medical Center, Duke Cancer Institute, Durham, NC, ¹⁰Fundación Oceanogràfic de la Comunitat Valenciana, valencia, Spain

In their evolution to a fully-aquatic lifestyle, marine mammals have accumulated a suite of physiological, anatomical, and molecular adaptations that support this land-to-water transition. In particular, these species have evolved unique oxygen-conserving mechanisms to prolong their breath-hold capacity and time available for foraging at depth. Yet, little attention has been paid to the cellular and molecular mechanisms that may augment the marine mammal dive response or how these protective adaptations for diving may respond to physiological disturbance. Our limited knowledge of cellular and molecular adaptations is predominantly due to the substantial challenges in obtaining and propagating live tissue from free-ranging marine mammals. To address these limitations we have established a system to propagate primary fibroblast cell lines from skin biopsies of multiple cetacean species, including bottlenose dolphins (Tursiops truncatus), short-finned pilot whales (Globicephala macrorhynchus), sperm whales (Physeter macrocephalus), and Cuvier’s beaked whales (Ziphius cavirostris), to examine the molecular mechanisms that support their diving capacity. RNA-Seq data from whale cells exposed to hypoxia reveals suppression in the shift to glycolysis during hypoxia which is supported by an increased mitochondrial spare respiratory capacity compared to human fibroblasts as revealed by metabolic profiling. This spare respiratory capacity is associated with increased mitochondria as well as genes involved in mitochondrial biogenesis. Together, these results suggest that whale cells may have unique molecular adaptations to tolerate hypoxia and increase metabolic capacity in the face of low oxygen. Additional work using 3D organoid model systems is ongoing to more faithfully recapitulate organ-level responses. Ultimately, cell culture models represent an unprecedented opportunity to study the cellular and molecular adaptations of marine mammals using controlled laboratory experiments and genomics.
full-time and 66 animals were determined to be part-time residents. Full-time and part-time residents associated in three social tribes, with encounters consisting of members of multiple tribes commonly observed. Association patterns were highly correlated to site-fidelity, indicating the presence of a unique residential group which regularly interacts with transient animals likely passing between Central Florida and Biscayne Bay. Future research within this natural corridor will focus on habitat utilization by residents and transients, and the behavioral nature of encounters between social tribes.

**Startling Seals to Save Salmon: Assessing effectiveness of an acoustic deterrent with a statistical application of CReSS-SALSA 2D**

Laura Bogaard¹, Rob Williams², Vincent Janik³, Steve Bockland⁴

¹Oceans Initiative, ²Oceans Initiative, Alert Bay, British Columbia, ³University of St Andrews, St Andrews, Fife, United Kingdom, ⁴University of St Andrews, United Kingdom

This study presents the first implementation of a new acoustic deterrent, Targeted Acoustic Startle Technology (TAST) as a conservation tool to mitigate over-predation on an endangered population of Chinook salmon (Oncorhynchus tshawytscha) by harbour seals (Phoca vitulina) at a vulnerable point along their migration path at the Ballard Locks in Seattle, Washington. The device was deployed for ten days, and trained observers recorded seal occurrence and behaviour in the study area while the device was on and off. A species distribution modelling technique called Complex Regional Spatial Smoother (CReSS) was applied to the spatial data with a Spatially Adaptive Localized Smoothing Algorithm (SALSA) to automate knot selection. The model was used to predict the probability of seal occurrence over the two-dimensional study area as a function of whether the TAST was on or off, and other smooth covariates. The model predicted that overall, seal presence probability did not change as a result of the TAST, but rather the spatial distribution of seals in the study area was further and more spread out when the device was on. This study demonstrates the TAST's effectiveness, and establishes its potential as a conservation tool for reducing seal predation intensity on an endangered population of Chinook salmon.

**High Resolution Mass Spectrometry to Identify New Hormone Targets for Pregnancy Detection in Blubber**

Ashley Boggs¹, Erin Legacki¹, Greta Dalle Luche², Susan Bengtson Nash¹

¹National Institute of Standards and Technology, Charleston, South Carolina, ²Griffith University, Nathan, QLD, Australia, ³The Southern Ocean Persistent Organic Pollutants Program, Griffith University

Blubber progesterone is used to determine pregnancy status of cetaceans; however, Dalle Luche et al. (2020) demonstrated that female Southern Hemisphere humpback whales (HW) nearing calving grounds do not have elevated blubber progesterone but have elevated androgens. It has been suggested that the specificity of the liquid chromatography tandem mass spectrometry (LC-MS/MS) could differentiate pregnanes, which could bind collectively to immunoassay progesterone antibodies, elevating progesterone measurements to significance. Therefore, we developed a new high-resolution (HR)LC-MS/MS method with superior mass accuracy to detect 10 pregnanes, 5 glucocorticoids, and 6 androgens, determine if the summation of pregnanes could detect late-gestation pregnancy, and identify additional pregnancy biomarkers in the blubber of HW. Blubber extracts from northward migrating (NM)HW with high androgens (n=5) and low androgens (n=3), as well as southern migrating (SM)HW with low progesterone (n=3) and moderate progesterone (n=6) were examined
using HR-LC-MS/MS. Mean peak areas were compared among groups using ANOVA. NMHW with elevated androgens had progesterone concentrations below the validated limit for pregnancy determination (<19 ng/g) and only one additional pregnane was detected (17α-hydroxy-progesterone). The ∑pregnanes per individual was ≤3.5 ng/g. Significantly elevated concentrations of androstenedione (p<0.001) and testosterone (p<0.001) were confirmed in addition to 11-deoxycorticosterone in three of the five animals. All detected hormones are associated with pregnancy in other species. In the SMHW with low progesterone one animal had low concentrations of 5α-dihydroprogesterone. Among the SMHW with moderate progesterone, 5α-dihydroprogesterone (p=0.008), 20α-hydroxyprogesterone (p<0.001), and progesterone (p=0.03) were elevated, all of which are associated with pregnancy in other cetaceans.

This study confirms that pregnancy in HW nearing calving grounds cannot be detected by measuring blubber progesterone, and other steroid biomarkers are present to determine pregnancy at different stages. The unparalleled scanning potential and specificity of HR-LC-MS/MS can be harnessed to assist in the selection of hormonal biomarkers to advance marine mammal endocrinology.

On the spatial-temporal distribution of the minke whales (Balaenoptera acutorostrata and B. bonaerensis) in the Wider Caribbean Region and adjacent Western Tropical Atlantic
Jaime Bolaños-Jiménez1, Eduardo Morteo2, Laurent Bouveret1, Christian Delfin-Alfonso2, Angiolina Henriquez2, Jolanda Luksenburg3, Nalleli Lara4, Antonio Mignucci4

1Sea Vida, CAGUA, Aragua, Colombia, 2Instituto de Investigaciones Biológicas, Universidad Veracruzana, Xalapa, Veracruz, Mexico, 3Observatoire des Mammifères Marins de l’Archipel Guadeloupéen (OMMAG), Port-Louis, Guadeloupe, France, 4Aruba Marine Mammal Foundation, Aruba, 5Arubamary Mammal Conservation Center, Bayamon, Puerto Rico

Until recently, minke whale sightings in the northern Atlantic Ocean (NA) were thought to belong exclusively to the common species Balaenoptera acutorostrata (CMW). Historical records confirm the presence of the CMW in the north-eastern Caribbean Sea during the winter months. However, the Antarctic minke whale (B. bonaerensis) (AMW) has been recently confirmed in the NA and Gulf of Mexico. We review and summarize the available records of both species to shed light on their spatial–temporal occurrence in the Wider Caribbean Region and adjacent NA (WCR-NA). We revised the literature, searched the internet (social networks and video-hosting websites), downloaded records available in biodiversity platforms, and added visual and acoustical records from the authors’ files. Finally, we used oceanographic model databases to search for patterns in spatial–temporal distribution. We collected 130 records, where 128 (98.4%) were classified as CMW, and 2 (1.6%) as AMW. One-hundred (76.9 %) records came from scientific accounts and 30 (23.1%) from citizen-science based contributions. Records include sightings (71.5%), acoustic detections (16.2%), strandings (11.5%), and takes (0.8%). Most records belong to the northern Caribbean (50.0%), eastern Caribbean north of Martinique (30.8%), the Gulf of Mexico (10.0%), and the NA (9.2%), and were acquired during the winter (66.2%) and (early) spring (28.5%) months, especially over the Caribbean upwelling season (December-March, 83.8%). Most of the CMW records correspond to three types of water masses, and also seemed to associate with extreme climatic events such as El Niño/La Niña. Calves/juveniles were recorded only on 6 occasions (4.6%). Low primary productivity during migration may limit feeding
opportunities for these whales. Increases in large-scale visual and acoustical surveys, and citizen-based initiatives has resulted in better availability of minke whale records within the study area. Our review confirms the WCR-NA as a wintering ground of the CMW from the North Atlantic.

**Low levels of genetic diversity and limited gene flow put dugongs at risk in New Caledonia**

Claire Bonneville¹, Claire Garrigue², Marc Oremus³, Christophe Cleguer⁴

¹UMR ENTROPIE Institute of Research for Development, New Caledonia, ²UMR ENTROPIE Institute of Research for Development, Noumea, New Caledonia, ³World Wildlife Fund, France, Noumea, New Caledonia, France, ⁴Murdoch University, Perth, Australia

A small and yet globally significant population of dugongs inhabits the New Caledonian waters at the eastern limit of the species’ distribution range. As non-migratory species, New Caledonia’s dugongs are likely to face a greater risk of genetic isolation than more central populations, bringing further concerns on a population already threatened by illegal hunting, collisions with vessels and by-catch. Here, we investigated genetic diversity and level of connectivity of this remote population in relation to previously documented populations across the species range in order to provide further insights into its conservation status. Between 2002 and 2020, a total of 55 skin samples were collected from which 538 bp of the mtDNA control region were sequenced. Haplotypes were compared to all dugongs’ published sequences (n= 631). The New Caledonian dugong population displayed the lowest level of mtDNA diversity documented worldwide (3 haplotypes with 1-bp difference), suggesting a recent origin of the current population through limited colonization events. Population structure analyses indicate a strong genetic differentiation with all the putative populations represented in the global data set, including large neighboring Australian populations. These low levels of gene flow suggest that large neighbouring stocks in Australia are unlikely to contribute significantly to the enhancing resilience of the dugongs’ population in New Caledonia. The conservation status of this local population is, therefore, even more precarious than previously thought. These results show that the dugong population in New Caledonia is particularly isolated, fragile, and vulnerable to anthropogenic threats and diseases with low potential for resilience through incoming gene flow. Our findings call for an instant conservation response and consideration for IUCN population assessment to support the long-term survival of the New Caledonian dugong population.

**Hearing them out: Acoustic behaviour of Indo-Pacific humpback dolphins in northwestern Peninsular Malaysia in relation to visually observed behaviour and anthropogenic activities**

Saliza Bono¹, Kotaro Ichikawa², Satoko Kimura³, Louisa Ponnampalam⁴

¹Kyoto University, Malaysia, ²Kyoto University, Kyoto, Kyoto, Japan, ³Kyoto University, Kyoto, Japan, ⁴The MareCet Research Organization, Shah Alam, Malaysia

In Malaysia, an increase of underwater noise is a great concern to the wellbeing of vulnerable marine mammals, which rely heavily on sound for communication, foraging and navigation to survive. Indo-Pacific humpback dolphins (*Sousa chinensis*) are the most commonly occurring delphinids in the coastal waters of the Langkawi Archipelago and adjacent mainland coast of Perlis-Kuala Kedah. The area, located in northwestern Peninsular Malaysia, is within a globally recognised IUCN Important Marine Mammal Area (IMMA), yet is faced with increasing tourism, maritime traffic and coastal developments, and is an intensive fishing ground.
This study aims to determine the impacts of anthropogenic noise on the acoustic behaviour of the Indo-Pacific humpback dolphins and compare their acoustics in differing visually observed behaviours. Three boat-based acoustic surveys were conducted in 2019 and 2020. Acoustic variables such as duration and frequency modulation were extracted to investigate their values against the varying visual behaviours (i.e. foraging, socialising, travelling) and group sizes observed. The whistle rates were analysed to determine the differences in baseline levels in the presence and absence of boats. We successfully recorded a total of 4,355 dolphin whistles using a pair of hydrophones deployed on both sides of the boat. The whistles had frequencies ranging from 1687 Hz to 37687.5 Hz and duration ranging from 0.025 s to 1.9 s. Results showed that there were no significant differences in the acoustic behaviour when compared to the varying visually observed behaviours. However, the whistle rate of these dolphins was higher before a boat was present, compared to during a boat present and after the boat passed by. The results showed that underwater noise from marine vessels had an impact on the dolphins’ whistle production. Findings from this research will allow for targeted conservation measures via sharing of findings and recommendations provided to the local authorities.

As ecosystems transform under climate changes and expanding human activities, a multidisciplinary integration of empirical research, conceptual frameworks and analytical techniques is required to predict, monitor and manage the cascading effects. We build on a decade of diverse research efforts to demonstrate the strengths of such integration for assessing population-level effects. Specifically, we focused on a case study of sublethal behavioral responses to disturbance by blue whales (Balaenoptera musculus) exposed to military sonar in the eastern north-Pacific. We combined data from individuals experimentally exposed to military sonar signals in Behavioral Response Studies with fine-scale measurements of baseline behavior over multiple days or weeks obtained from accelerometry loggers, telemetry tracking and prey sampling. Simulations of movement, feeding behavior and exposure to realistic sonar events were used to predict the effects on an individual’s daily energy acquisition. These simulations converted observed behavioral responses into a common currency that could be effectively integrated in a dynamic state variable model for blue whale vital rates. We used the resulting model to simulate scenarios of sonar disturbance and environmental change. Environmental changes were predicted to severely affect vital rates, while the current
regime of sonar activities was not. However, variation in individual exposure rates should be monitored as the environment shifts. A sensitivity analysis of model outputs showed that information on prey resources is critical for robust predictions, as are data on baseline behavioral patterns, energy budgets, morphology and contextual responses to noise. Our study can inform effective management of anthropogenic stressors in the context of a changing environment. In general, it provides an example of how predictive tools, building on research from diverse fields, can be developed to support management solutions that minimize risks for wildlife populations, guide monitoring strategies for signs of ongoing effects, and highlight the key data required to reduce uncertainties.

Estimating pregnancy rate from blubber progesterone levels of a blindly biopsied beluga population poses methodological, analytical and statistical challenges

Xavier Bordeleau¹, Limoilou-Amélie Renaud¹, Nicholas Kellar², Robert Michaud³, Stéphane Lair⁴, Yves Morin¹, Ariane Therien³, Veronique Lesage⁶
¹Fisheries and Oceans Canada, Mont-Joli, Quebec, ²NOAA Fisheries, La Jolla, CA, ³Group of Research and Education on Marine Mammals, Tadoussac, Québec, ⁴Université de Montréal, ST. HYACINTHE, Quebec, ⁵Maurice Lamontagne Institute, Fisheries and Oceans Canada, ⁶Fisheries and Oceans Canada, Mont Joli, Quebec

The beluga (Delphinapterus leucas) population in the St. Lawrence Estuary (SLE), Canada, has shown low calf survival since 2000, suggesting that poor reproductive success or fecundity might contribute to the documented population decline. Pregnancy is difficult to detect through observation, and ground-truthing pregnancy estimates with individuals of known reproductive success is rarely possible in the wild. To determine the blubber progesterone threshold associated with pregnancy, we first contrasted progesterone concentrations among 63 SLE beluga of known reproductive status (i.e., pregnant, non-pregnant, and lactating female) that were found dead in 1997—2019. We then evaluated the suitability of using progesterone thresholds from these decaying carcasses to assess the reproductive status and pregnancy rates of wild beluga blindly-sampled via 1)135 fresh carcasses from the Nunavik beluga subsistence harvest, and 2) 65 biopsies from wild-ranging SLE beluga. Blubber progesterone concentrations were considerably higher in pregnant (mean ± SD: 341 ± 248 ng g⁻¹ of tissue), than non-pregnant (57 ± 158 ng g⁻¹ of tissue), or lactating females (105.7 ± 224 ng g⁻¹ of tissue) in decaying carcasses from individuals of known-reproductive status. While our findings confirm the validity of the method to identify pregnancy, the inference of pregnancy status of blindly sampled animals was challenging for the biopsied animals, for which low lipid contents may lead to underestimated progesterone levels and pregnancy rates, if unaccounted for. Mismatches in assignations of reproductive status occurred for samples with low lipid content (<6% of sample weight) in wild-ranging belugas. We suggest that studies with low sample size on in which hormone concentration is predominantly dependent on fat content should present both measurement unit (ng g⁻¹ of tissue and ng g⁻¹ of lipid) thereby providing a promising tool to quantify pregnancy rates from free-ranging population.

North Atlantic Right Whale (Eubalaena glacialis) Scenario Planning: Exploring future ocean and human conditions to improve recovery

Diane Borggaard¹, Dorothy Dick²
¹NOAA Fisheries Greater Atlantic Regional Fisheries Office, Gloucester, MA, ²Ocean Associates Inc. under contract for NOAA Fisheries Office of Protected Resources, Silver Spring, MD
North Atlantic right whale (*Eubalaena glacialis*) recovery planning has been informed by taking a forward-looking scenario planning approach to reinforce and/or discover important immediate and long-term actions. Scenario planning is used by many resource management organizations, but its use by NOAA Fisheries is relatively new. In 2020, NOAA Fisheries published the results of a scenario planning exercise for North Atlantic right whales conducted with experts in right whale-related science (e.g., large whale, fishing gear, climate, oceanography, zooplankton, ecosystem, ecology, health, harmful algal blooms) and management (e.g., aquaculture, wind energy, fisheries, entanglement, vessel strike, acoustics). This multidisciplinary approach helped us consider four different but plausible future scenarios for right whales based on projected changes in ocean conditions coupled with anthropogenic stressors. The scenarios offered an opportunity to explore what each future might mean for right whales while helping NOAA Fisheries and their partners better prepare for the future through near-term actions. We identified right whale management and research actions that complemented priorities identified elsewhere and/or reinforced recovery efforts already underway (e.g., reduce impacts from fishing interaction and vessel strikes). The process also emphasized the importance of putting additional effort towards “novel” actions and/or new, emerging threats (e.g., investigate potential climate-induced right whale prey changes in southern New England). In addition to numerous activities initiated in response to this exercise, our results continue to inform recovery efforts such as priorities in various NOAA Fisheries recovery efforts (e.g., NOAA Fisheries Species in the Spotlight/North Atlantic Right Whale Priority Actions: 2021-2025) and expanded collaborations (e.g., membership in the newly reconvened North Atlantic Right Whale Northeast U.S. Implementation Team). This exercise provides an important example for other marine resource managers to address similar conservation issues, especially as scenario planning continues to gain momentum for marine species/environments.

**Linking dive behavior with quantitative prey-specific fatty acid diet estimation using machine learning tools in a free-range ocean predator**

**Renato Borras-Chavez**, Mike Goebel, Luis A. Hückstädt, Stella Villegas-Amtmann, Fokke J. Dijkstra, Alicia Guerrero, Suzanne Budge, José Miguel Fariña, Francisco Bozinovic

1 Center of Applied Ecology and Sustainability-CAPES, Pontificia Universidad Catolica de Chile, Punta Arenas, Chile, 2 NOAA - Fisheries, 3 Institute of Marine Sciences, University of California Santa Cruz, Santa Cruz, California, United Kingdom, 4 Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, California, 5 Amsterdam, Netherlands, 6 Universidad de Valparaíso, 7 Department of Process Engineering and Applied Science, Dalhousie University, 8 Center of Applied Ecology and Sustainability-CAPES, Pontificia Universidad Católica de Chile, Santiago, Chile

Bio-logging tools have opened the door to quantify behavior in ocean predators. Today, we can identify the exact moment of prey capture attempts. However, most instruments fail to identify the prey species consumed, and those that can do so, still have limited memory capacity or demand additional instruments to be carried by the animals. Time Depth Recorders have been used for decades, accounting for much of our knowledge of many species’ dive behavior, including the Antarctic fur seals (AFS). Novel quantitative fatty acid signature analyses of AFS milk provide a unique opportunity to determine the proportion of prey consumed per foraging trip and link this information with diving behavior. Using machine-learning analyses and modeling, we link dive behavior to proportional data of consumed prey derived from fatty acids.
of milk samples extracted immediately after each trip. We generated a predictive algorithm using Random Forest Analysis. We trained the algorithm with diving information of foraging trips from which we knew females consume only one prey species (krill or myctophid). Later, the algorithm was tested on trips associated to samples with known combined prey proportions. Our model showed a predictive accuracy of 76.2%. The model selected the ascent rate as the most reliable diving variable to differentiate diving behavior between prey type (selected 100% of the time in all decision trees) followed by ascent time (69%), maximum depth (69%), and descent rate (60%). This is consistent with the literature suggesting that when capture attempts occur in AFS, changes in the vertical phase of a dive are observed. Furthermore, differences in behavior are consistent with different prey vertical migration patterns. Currently, we are testing other machine learning methods to increase predictive accuracy and better characterize foraging strategies, including the targeted prey species information at any given time of a foraging trip.

**Weddell seals and melting glaciers**

Guilherme Bortolotto¹, Lars Boehme²

¹University of St Andrews, St Andrews, Fife, United Kingdom, ²University of Andrews, St Andrews, United Kingdom

Glaciers in the Amundsen Sea are facing some of the fastest rates of ice loss in Antarctica, and the area is expected to be severely impacted by the effects of global warming in the next decades. The fate of the marine mega-fauna inhabiting those waters remains uncertain. Strongly associated with sea ice, the Weddell seal is one such species likely to be affected. Understanding how they use that habitat is key to predict ecological changes in that system. Not much is known about their prey species in the area, therefore, environmental drivers possibly influencing seal movement and distribution need to be identified, allowing for physiological constraints of potential prey. Here we present movement and distribution data from 19 Weddell seals (*Leptonychotes weddellii*) equipped with behavioural and oceanographic tags in 2019 and 2020 in the Amundsen Sea, Antarctica. The horizontal movement and dive data highlight that the seals dive to a triple point in space, where the warmer modified Circumpolar Deep Water interfaces with the much colder overlaying Winter Water at a sloping sea bed. This often occurs at depths around 400m, well within the diving capabilities of Weddell seals. The benthic community living at this boundary, but still in warmer water, must provide a better habitat for the Weddell seal’s prey than the shallower-colder benthic communities. We hypothesise that the seals feed on *Trematomus* fish, which is less adapted to cold water than *Channichthyidae*. The distribution of Weddell seals in the Amundsen Sea Embayment in the future will depend on how well the species, and their prey, can adapt to shifts in the most important factors defining their environmental space.

**Exploring patterns of responsiveness to sonar exposure: a Bayesian approach applied to multiple cetacean species**

Phil Bouchet¹, Catriona Harris², Elizabeth Henderson¹, Dina Sadykova³, Len Thomas²

¹University of St Andrews, St Andrews, Fife, United Kingdom, ²CREEM, University of St Andrews, St Andrews, Fife, United Kingdom, ³SPAWAR/Navy Marine Mammal Program, San Diego, California, ⁴UK Centre for Ecology & Hydrology

Evaluating the impacts of anthropogenic underwater noise on cetacean populations has become a key requirement of contemporary environmental management across the world’s oceans. Of particular interest is the ability to predict the nature, onset, and magnitude of species’ responses to impulsive sound stimuli, such as those produced by naval sonar systems.
Current noise exposure criteria for risk assessments are often based on classifications of species into functional hearing groups, yet increasing evidence for suites of complex responses that are both context-dependent and individually variable challenge the idea that sonar effects are universally mediated by species morphology and hearing sensitivity. We summarise the development and application of an alternative, data-driven approach for investigating mechanisms influencing behavioural responses within a Bayesian multi-species hierarchical dose-response framework. Our method relies on a “dimension-jumping” reversible-jump Markov chain Monte Carlo (rjMCMC) algorithm, and offers an objective, tractable, and computationally efficient way of identifying other biologically-relevant species groupings by assessing competing hypotheses regarding shared patterns of responsiveness to sonar and sonar-like signals. The method also accommodates: (1) the selection of explanatory covariates (e.g., sonar frequency, previous history of exposure, feeding behaviour, source-whale range), (2) the comparison of dose-response functional forms (i.e., monophasic or biphasic), and (3) the appropriate treatment of right-censored observations (i.e., when animals display no signs of behavioural response across the array of doses received). We demonstrate its potential using an existing dataset on the expert-scored response thresholds of thirteen cetacean species tagged during behavioural response studies conducted in the Atlantic and Pacific Oceans. Our results provide novel insights into how responsiveness to sound can be generalised within and across species to inform impact assessment processes.

Influence of environmental parameters on group size, occurrence and spatial distribution of bottlenose dolphins in northcentral Gulf of Mexico

Thibaut Bouveroux1, Carrie Sinclair2, Kevin Barry2, Lauren Clance1, Carl Cloyed4, Keith Mullin5, Ruth H. Carmichael6

1University of South Alabama, Dauphin Island Sea Lab, Dauphin Island, AL, 2NOAA, Pascagoula, MS, 4University of South Alabama, Dauphin Island Sea Lab, Mobile, Alabama, 4Dauphin Island Sea Lab, Dauphin Island, AL, 5NOAA Fisheries Southeast Fisheries Science Center, Pascagoula, MS, 6Dauphin Island Sea Lab/ University of South Alabama, Dauphin Island, Alabama

Bottlenose dolphins inhabit bays, sounds, estuaries and coastal waters year-round in the northcentral Gulf of Mexico. This region is subject to significant freshwater discharges, which affect the salinity and water temperature within the home range of local dolphins, potentially affecting their health and survival. There are currently poor baseline data to inform site fidelity of dolphins in this region that might affect their resilience to these environmental perturbations. To define how dolphin populations are affected by seasonal environmental variation, particularly salinity and temperature, we conducted capture-mark-recapture photo-identification surveys of dolphins in two major embayments in Alabama, USA. We documented group size, behaviors and demographics during summer and winter seasons for two years. Encounter rates and relative abundance of dolphins differed between embayments and seasons. Although dolphins were mainly observed in higher salinity waters (> 15 PSU), they were frequently observed using areas of extremely low salinity (ranging 0.1 to 5 PSU), especially for feeding activities. Preliminary results also suggest that group size of dolphins was not influenced by salinity or water temperature. Overall, during this study, changes in oceanographic parameters affected the spatial distribution of dolphins among and between seasons, in particular in areas where salinity was low, but stressful conditions did not preclude their occurrence and habitat use. Additional study is needed to determine if dolphins in the northcentral Gulf of Mexico may be behaviorally
or physiologically adapted to manage these stressful habitats or suffer reduced long-term survival compared to populations in other regions.

A Case Study on the Effects of Plastic Ingestion on a Stranded Rice’s Whale in Everglades National Park, Florida

Denise Boyd¹, Emily Davidson², Hada Herring, Molly Schubert, Ana Nader, Anna Panike³, Gina Lonati⁴, Brittany Barbeau⁵, Sean Tennant⁶, Jessica Blackburn⁷, Gretchen Lovewell⁸, David Rotstein⁹, Blair Mase-Guthrie¹⁰, Daniel Levine¹¹, Rebeccah Hazelkorn¹²

On January 29th, 2019, a 37 ft., male, Rice’s whale (formally the Gulf of Mexico Bryde’s whale) carcass was reported in Flamingo, Florida Bay, Everglades National Park (ENP). Video footage captured by a citizen revealed that the whale was alive and free-swimming on January 27th. The Florida Fish and Wildlife Conservation Commission (FWC)-Southwest Field Laboratory coordinated and led a multi-agency response to perform a detailed necropsy of the whale to investigate the cause of stranding and death. Gross necropsy findings included a thin body condition, froth and fluid in the airways, and pulmonary edema, which are consistent with a live stranded, moribund whale that subsequently drowned. Additionally, a small, sharp piece of plastic was found in the pyloric stomach and resulted in acute necrotizing and hemorrhagic gastritis. Gross findings were supported by histopathological examination of sampled lesions. These findings combined with the absence of other detectable infections, pathologies, toxins or trauma, provided strong evidence that the plastic likely contributed to inappetence and inanition, ultimately leading to the whale’s drowning and death. Therefore, the cause of stranding was diagnosed as plastic ingestion, and the cause of death was drowning. This investigation contributed to an improved understanding of the threats faced by this rare whale species and served as an impactful message to promote public awareness through social media platforms. Additionally, the skeleton, in its entirety, was collected and is preserved at the Smithsonian National Museum of Natural History to serve as the scientific representative (type specimen) for the newly described species Rice’s whale (Balaenoptera ricei). Genetic analyses and a morphological examination have been conducted on this specimen to further our understanding about this endemic Gulf of Mexico species.

Relationships between gene transcription and contaminant concentrations in Baltic ringed seals: a comparison between tissue matrices

Joy Ometere Boyi¹, Iben Stokholm², Miriam Hillmann³, Jens Søndergaard⁴, Sara Persson⁵, Cynthia A. de Wit⁶, Ursula Siebert⁷, Kristina Lehnert⁸
¹Institute for Terrestrial and Aquatic Wildlife Research, University of Veterinary Medicine, Hannover Foundation, Buesum, Germany, ²PhD student, Copenhagen, Copenhagen, Denmark, ³Department of Bioscience, Aarhus University, Roskilde, Denmark, ⁴Swedish museum of natural history, Stockholm, Sweden, ⁵Department of Environmental Science, Stockholm University, Stockholm, Sweden, ⁶Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of...
Veterinary Medicine Hannover, Foundation, Buesum, Schleswig-Holstein, Germany, Institute of Terrestrial and Aquatic Wildlife Research, University of Veterinary Medicine Hannover, Buesum, Germany

Ringed seals are slowly recovering in the eastern and northern parts of the Baltic Sea after years of hunting pressure and contaminant exposure. Still, contaminant exposure and increasing temperatures continue to have deleterious effects on their health. To assess the health status of Baltic ringed seals, we measured the levels of selected persistent organic pollutants in blubber and liver, and total mercury concentration in liver and muscle. For the first time, mRNA transcript levels of seven health related genes; aryl-hydrocarbon receptor nuclear translocator (ARNT), peroxisome proliferator-activated receptor alpha (PPARα), thyroid hormone receptor alpha (TRα), thyroid stimulating hormone receptor beta (TSHβ), retinoic acid receptor alpha (RARα), estrogen receptor alpha (ESR1) and heat shock protein 70 (HSP70) were quantified in blood, blubber and liver of the same ringed seal samples using RT-qPCR. Mean concentration of POPs (PCBs, PBDEs, DDTs) did not vary across tissues on a lipid weight basis or between sexes, but adults had higher levels compared to sub-adults. mRNA transcript levels for all seven target genes did not vary between sexes or age classes and higher transcript levels of most genes (ARNT, PPARα, TSHβ, RARα and ESR1) were observed in the blubber. Correlation analyses between contaminants and mRNA transcript levels revealed significant relationships between PPARα and PBDE in blubber, ARNT and PCB in liver, while HSP70 was related to mercury concentration in the liver. Our results reflect a continued high exposure of Baltic ringed seals to PCBs despite the ban, and contaminant-associated health effects. The wide range of genes expressed in the blubber highlights the value of minimally invasive sampling for assessing health endpoints in free ranging marine wildlife. This study has provided new information on the status of Baltic ringed seals for the first time in decades and will be a useful guide for conservation and management of Baltic pinnipeds.

Ethology Of Stranded Cetaceans In New Zealand: First Insights For An A Priori Ethogram
Rebecca Boys¹, Emma Betty², Ngaio Beausoleil³, Karen Stockin⁴
¹Massey University, ²Massey University & Auckland University of Technology, Auckland, New Zealand, ³Massey University, Palmerston North, New Zealand, ⁴Massey University, Auckland, New Zealand

New Zealand has an international reputation for its high incidence of cetacean strandings and human intervention at these events. However, matters of animal welfare, including effects of human manipulation remain unknown. In order to address this, fine-scale empirical data on the ethology of stranded cetaceans is reported here. We describe and quantify the behavioural and physiological events displayed and examine for effects of human intervention. GoPro Hero 7 cameras mounted cranio-laterally and angled caudally were used at strandings to collect fine ethological events of stranded whales for subsequent video. Effects of human intervention were investigated by assessing event duration with human presence/absence and manipulations (watering, rolling, touching, noise, digging, reflex tests). A total of 6,634 animal events were recorded in program BORIS, involving 19 different behavioural/physiological indicators. Animal 1 and 2 displayed 18 and 12 of these classified events, respectively, with 11 of the events displayed by both individuals. The frequency and duration of events varied significantly between individuals and over time. No difference between individual whales was evident during human intervention. However, during particular manipulations (noise, rolling and digging) certain events showed a higher
probability of occurrence. For example, head side
to side had an average probability of occurrence
of 0.96 vs 0.33 during and in absence of human
noise. These data provide the first insights into
the ethology of stranded cetacea and can be used
to build an a priori ethogram for the assessment
of future stranding events.

**Sampling from commercial vessel routes can
capture marine megafauna distributions
effectively**

Elizabeth Boyse¹, Simon Goodman², Elena
Valsecchi³, Maria Beger⁴
¹University of Leeds, United Kingdom, ²Institute
of Integrative and Comparative Biology,
University of Leeds, Leeds, United Kingdom,
³University of Milano-Bicocca, Italy, Milan,
Italy, Italy, ⁴University of Leeds, Leeds, **Non-
US resident**, United Kingdom

Collecting fine-scale occurrence data for marine
megafauna across large spatial scales is
logistically challenging, but is important for
modelling species distributions and marine
spatial planning. Inaccurate descriptions of
species ranges could result in important habitats
remaining unprotected or inappropriate
prioritization of areas with few species
occurrences. Optimizing sampling strategies
therefore is a priority for scaling up survey
approaches using tools such as environmental
DNA (eDNA) to support conservation planning.
eDNA can detect diverse taxa simultaneously,
but to date has rarely been applied across large
spatial scales in the marine environment.

Commercial vessels, such as ferries, could
provide sampling platforms allowing access to
undersampled areas and repeatable sampling
over time to track community changes. However,
sample collection from commercial vessels could
be biased through not representing environmental
diversity in the area of interest. Here we evaluate
stacked-species distribution models of marine
megafauna, including mammals, sharks,
and predatory fish, in the Mediterranean as an
example of perfect knowledge to optimize
sampling strategies along commercial shipping
routes. Simulations were carried out representing
different sampling strategies (random vs
systematic), frames (ferries vs Mediterranean)
and number of sampling points. We recovered
important biodiversity patterns, such as gradients
of species richness, from samples collected along
ferry routes when the ferry routes chosen were
not climatically biased. Across a range of sample
sizes and strategies, ferry routes consistently
accumulated more species and more occurrences
per species compared to the whole
Mediterranean. Simulations incorporating
random and systematic detection bias via eDNA
can estimate sample sizes necessary to evaluate
species occurrences within specified probability
thresholds. The workflow presented here can be
used to design effective eDNA sampling
strategies using commercial vessel routes. This
has potential to provide a cost-effective method
to access remote oceanic areas on a regular basis,
and can recover meaningful data on
spatiotemporal biodiversity patterns.

**Why not? Estimating the Winter Abundance
of Cetaceans around the Main Hawaiian
Islands**

Amanda Bradford¹, Kym Yano², Erin Oleson³
¹Pacific Islands Fisheries Science Center, NOAA
Fisheries, Honolulu, Hawaii, ²CIMAR, NOAA
Pacific Islands Fisheries Science Center,
Honolulu, HI, ³NOAA NMFS Pacific Islands
Fisheries Science Center, Honolulu, Hawaii

Twenty-four cetacean species (18 odontocetes, 6
mysticetes) regularly occur in the waters around
the main Hawaiian Islands. Abundance estimates
are needed to evaluate the impacts of human
activities on these species in population
assessments and management plans. Most ship-
based, line-transect surveys for cetaceans in
Hawaiian waters have occurred during the
summer-fall period, including the recurring
Hawaiian Islands Cetacean and Ecosystem
Assessment Survey (HICEAS) that took place in 2002, 2010, and 2017. There are no recent abundance estimates of Hawaiian cetaceans during winter, when the abundance of seasonally-migrating baleen whales is at its peak. A winter HICEAS (WHICEAS) was conducted in Jan-Mar 2020 to estimate the abundance and distribution of cetaceans around the main Hawaiian Islands during winter. An established multiple-covariate approach, which involves pooling data from previous line-transect surveys to estimate detection functions and using trackline detection probabilities that consider the effect of survey sighting conditions, was used to produce design-based abundance estimates for 16 species (13 odontocetes and 3 mysticetes). Across all species, abundance point estimates range from 115 fin whales to 26,627 melon-headed whales. Low encounter rates led to high CVs (range=0.40-1.04) for most estimates and low statistical power to detect seasonal trends in abundance for the 9 odontocete species sighted around the main Hawaiian Islands during HICEAS 2017 and WHICEAS 2020. Given a lack of sightings from island-associated odontocete populations, the WHICEAS 2020 estimates are of the pelagic populations for species where both are recognized. The resulting abundance of 2,975 humpback whales (CV=0.40, 95% CI=1,407-6,291) is the first estimate from the main Hawaiian Islands since the SPLASH project of 2004-2006. The estimates of all other species represent the first assessment of winter abundance in the study area. Ongoing model-based abundance estimation will provide finer-scale seasonal and spatial inference for 9 species (8 odontocetes and humpback whales).

Behavior related vocalizations of the Florida manatee (Trichechus manatus latirostris)
Beth Brady¹, Jon Moore², Kim Love²
¹Mote Marine Aquarium, POMPANO BEACH, FL, ²Florida Atlantic University

Florida manatees (Trichechus manatus latirostris) produce five broadly defined call types (squeaks, squeals, high squeaks, chirps, squeak-squeals) but their use in social and nonsocial settings is unclear. Multiple hydrophones were used to record manatee vocalizations in four different environments and broad behavioral states. Vocalizations recorded from resting, cavorting, stressed and feeding animals were subjected to mixed linear effects models to test whether vocalizations produced varied with behavior and calf presence. Measures of duration, entropy, and frequency modulation were extracted from vocalizations to investigate if structural parameters differ between behaviors. Results suggest manatees vocalize using three call types and vary the structure of the call based on behavior. High squeaks were correlated with calf presence. High entropy squeals were proportionally higher during cavorting suggesting they may be related to a heightened state of arousal. Squeaks were the dominant call type produced amongst all behavioral states and were longer in duration and higher in frequency modulation when animals were stressed. This research provides a foundation for comparative studies on behavior related vocalizations for the Florida manatee as well as future studies on related species.

Highly Identifiable common dolphins show long-term residency patterns around São Miguel island, Azores
Milla Brandão¹, Laura González Garcia¹, Bárbara Costa¹, Fadia Al Abbar²
¹University of Algarve, Faro, Faro, Portugal, ²Wageningen University, Ponta Delgada, Portugal

Short-beaked common dolphin, Delphinus delphis, is among the most frequently sighted cetacean species in the Azores, becoming of relevant importance for the whale watching industry, which supposes at the same time an undeniable economic input for the region. They are sighted year round, however,
their residency patterns have not been yet consistently analysed. This work aimed (1) to identify “Highly Identifiable Individuals” (HII), i.e. those with very distinctive marks, from 12 years of whale watching opportunistic data (2008-2019) collected by Futurismo Azores Adventures; and (2) to do a first assessment of the residency patterns of the species around São Miguel island, Azores. Encounter rates of common dolphins calculated from 3879 sightings and 4552 trips were higher in winter than in summer months. Calves, including newborns, presented higher encounter rates in June and October. The photo-identification process yielded a total of 978 individuals identified from 5698 photos (484 identified by the right side, 420 by the left side, 72 by both). Two anomalously pigmented individuals (one melanistic and one leucistic) were re-sighted, both 17 days after the first sighting. From all, 856 individuals were sighted once and the remaining 122 were re-sighted between 2 and 9 times. Twelve individuals were season-related (re-sighted in different years but same season), and only 56 were considered as residents, for being re-sighted in different years and seasons. The longest interval between first and last re-sighting of the same individual was 11 years. This is the first study considering a long-term data series of Delphinus delphis in Azores, and using ‘HII’ to analyse residency patterns. Our results suggest the existence of resident individuals regularly sighted in specific areas (i.e. south coast of São Miguel island).

This information might be of great importance to support appropriate conservation or management decisions in the region.

**Characterizing DHEAS in Zoo-Housed Polar Bears**

Monica Brandhuber¹, Shannon Atkinson DeMaster², Erin Curry³, Terri Roth¹, Heidi Pearson⁴, Curry Cunningham⁵

¹University of Alaska Fairbanks, Juneau, Alaska, ²University of Alaska Fairbanks, ³Cincinnati Zoo and Botanical Garden, Cincinnati, Ohio, ⁴University of Alaska Southeast, Juneau, Alaska, ⁵University of Alaska Fairbanks, Juneau, AK

Polar bears (Ursus maritimus) in the wild are under threat due to climate change, pollutants, and habitat disturbances. Some populations may also experience poor reproductive success, as they do in zoos. Embryonic diapause and pseudopregnancy complicate characterization of reproductive function in this seasonally polyestrous species. Excretion of testosterone and progesterone have been studied extensively in zoo-housed polar bears, but have limited capacity for predicting reproductive success. The purpose of this study is to characterize a suite of hormones that can serve as bioindicators of reproductive success in polar bears. One of these biomarkers is the steroid hormone precursor dehydroepiandrosterone (DHEA), which can be found in the sulfated form DHEAS in feces. DHEA is not well understood, but has been correlated with reproductive success in other species. Using enzyme immunoassays, we determined the longitudinal and seasonal excretion patterns of DHEAS in the lyophilized fecal samples of zoo-housed polar bears. This study included pregnant females (n = 10), females that bred but failed to produce cubs (n = 11), a non-breeding sexually mature female, a juvenile female, and a breeding male. There was no difference (P > 0.05) between the average baseline DHEAS concentrations during the breeding season for the pregnant bears (165ng/g ± 76ng/g) and those that failed to produce cubs (280ng/g ± 136ng/g). However, individuals in both groups exhibited elevated DHEAS concentrations (Range: 320ng/g – 9006ng/g) throughout the breeding season that were closely associated with testosterone excretion and often elevated on dates the animals were observed breeding. Comparably elevated DHEAS concentrations were not observed in the non-breeding female (baseline: 172ng/g ± 80ng/g) or the juvenile female (baseline: 130ng/g ± 59ng/g), or outside of the breeding season. This finding
suggests that DHEAS is related to estrus or ovulation in female polar bears, and may be a useful supplement to testosterone monitoring.

The fine-scale behavior of harbor porpoises towards pingers

Dennis Brennecke¹, Ursula Siebert², Lotte Kindt-Larsen¹, Henrik Midtiby⁴, Henrik Dyrberg Egemose⁵, Sara Torres Ortiz⁶, Katrin Knickmeier⁷, Magnus Wahlberg⁸
¹Kieler Forschungswerkstatt, Kiel, Schleswig-Holstein, Germany, ²Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Buesum, Schleswig-Holstein, Germany, ³DTU Aqua, Technical University of Denmark, Charlottenlund, dk, ⁴University of Southern Denmark, Odense, Funen, Denmark, ⁵The Maersk Mc-Kinney Moller Institute, University of Southern Denmark, Denmark, Odense, Funen, Denmark, ⁶Max-Planck-Institute for Ornithology, Puerto de la Cruz, Santa Cruz de Tenerife, Spain, ⁷Kieler Forschungswerkstatt, Kiel, Germany, ⁸Marine Biological Research Centre, University of Southern Denmark, Kerteminde, Funen, Denmark

Bycatch is one of the most urgent threat for many cetaceans. Thousands of harbor porpoises (Phocoena phocoena) are incidentally bycaught in gillnets every year. To prevent bycatch of this species in fishing gear, acoustic alarms (pingers) have been demonstrated to be an efficient mitigation tool. However, little is known about the behavioral reactions of wild porpoises to pingers. Therefore, we tracked 16 wild porpoises with a drone and recorded their behavior before and during exposure to pinger sounds in Danish waters. In four of the exposures the reaction towards the pinger was strong avoidance behavior with increased swimming speed and tail stroke frequency heading away from the pinger. Surprisingly, four animals did not respond to pinger sounds which demonstrates a diversity in the behavioral response. In addition, the reaction of the animals towards the pinger was not affected neither by the behavior of porpoises before sound exposure, nor by the porpoise-to-pinger range nor by the relative direction of porpoise to pinger. Pingers can cause very strong aversive reactions in harbor porpoises, which explains their efficiency in reducing bycatch. However, strong aversive reactions may suggest that pinger use should be limited to critical time periods and regions, or more focus needs to be put on optimizing passive acoustic devices causing less severe behavioral reactions.

Diversity and frequency of the african manatee threats along the lower ntem river of southern cameroon

EDUKE Bridget AKUME¹, Lucy Keith-Diagne¹, Clinton Factheu²
¹The university of Yaounde 1, Yaounde, centre, Cameroon, ²University of Yaounde 1, Yaounde, Center Region, Cameroon

The African manatee (Trichechus senegalensis) is one of the most threatened sirenian, yet the least studied. Present in 21 countries in west Africa thus, the former name ‘West African manatee’. With increased human population in Campo resulting from the newly constructed kribi sea port and the informal nature of fisheries in Cameroon, there is increased possibilities for interruption of aquatic wildlife. The objective of this study was to investigate the type and frequency of threats on the African manatee. The present work is the first threat assessment on the African manatee along the ntem river. In the months of August 2020 and January 2021 (high fishing seasons), a survey on the different manatee threats and their frequencies was tackled in four villages along the lower ntem river. 150 fishers with fishing experience >10 years were selected at random and interviewed individually using structured questionnaires. Information about manatee death were registered as far back as 10 years. This study reveal that entanglement is the most frequently occurred
threat. An average of 5 manatees/year were trapped in nets and had prejudicial impacts on both the manatee and the fishers. Fishers maintained that trapped manatees were often released alive though the researcher doubted the statement. While most of the respondents claimed manatees die as a result of stranding, 7 courageous fishers accepted to have killed a manatee. Reduction of vegetal food resources due to high rate of water pollution has forced manatees to divert towards fish marauding hence, fisher-manatee conflict as fishers develop negative attitude towards this species, making the manatee population more vulnerable. A near absent implementation of national laws on manatee conservation was also noticed as conservation bodies focus their attention on great apes and elephants. A total of 21 deaths were registered with rib bones from the most recently killed manatee (September, 2018) collected by the researcher from a self-admitted poacher. Results from this research will help conservation bodies by providing data on fishing methods that are unfriendly to manatee conservation.

Evaluating the effectiveness of retrofitting water control structures with manatee protection systems to reduce mortality
Kristy Brightwell1, Brandon Bassett2, Ron Mezich3, Paul Schueller2, James Valade1, Kipp Frohlich2
1Florida Fish and Wildlife Conservation Commission, Florida, 2Florida Fish and Wildlife Conservation Commission, 3U.S. Fish and Wildlife Service

Reducing human-related mortality is a top management priority for Florida manatee (Trichechus manatus latirostris) conservation and recovery. Manatees encounter navigational locks (NL) and water control structures (WCS) along travel corridors and fatal encounters can result due to crushing or impingement, subsequently resulting in drowning. This study evaluates the effectiveness of manatee protection systems (MPS) at NL and WCS using negative binomial regression models and Friedman's test with pairwise comparisons from 1974-2018. Mortalities were stratified by mitigation efforts per structure at the time of death: None, Partial 1, Partial 2, and Full. Partial groups were combined in the Friedman's test. Regression models for 216 structure-related manatee deaths showed the expected number of annual mortalities was <0.33 for all mitigation groups at each structure type. Friedman’s test indicated a difference in mortalities among mitigation efforts for both NL ($\chi^2 = 17.641, P = 0.006$) and WCS ($\chi^2 = 10.16, P \leq 0.001$). Mortalities at fully mitigated WCS were lower than at partially mitigated structures in pairwise testing for both analyses, but NL mitigation efforts only differed in Wilcoxon rank sums tests. These differences may be due to potential misclassification of some mortalities in the regressional models. Importantly, the differences between partial and full mitigation suggest when the current MPS retrofitting is functional and SOPs are followed, mortality is significantly reduced.

Discrimination of odors in both aerial and aquatic environments in captive California sea lions (Zalophus californianus)
Jules BROCHON1, Isabelle Charrier2, Gérard Coureaud3, Cyril Hue4, Bérénice Crochu4
1Lugny, France, 2Université Paris-Saclay, Université Paris-Sud, CNRS, Institut des Neurosciences Paris-Saclay, 91405 Orsay, France, 3Equipe soigneur animalier – vétérinaire, Zoo de La Flèche, La Flèche, France

Pinnipeds, as any mammal species, use different sensorial signals including olfactory ones, to
ensure vital functions. Their auditory system is considered as highly developed but regarding olfaction, they have long been considered “microsmatic”. However, some pinniped species have been shown to use olfaction in both social (i.e., mother-young recognition) and foraging contexts. Experimental studies revealed they can discriminate between different odors in air including both natural and artificial odors, but studies on that topic remain scarce. Here, we studied the olfactory capabilities of California sea lions living in captivity at La Flèche Zoo (France) in both aerial and aquatic environments. We used two categories of odors: social odors (from familiar individuals of the same group, unfamiliar individuals from another Zoo, animal zookeepers and a terrestrial carnivore) and non-social odors (food and odors identified as repellents in certain vertebrates). Several behavioral parameters were measured and analyzed as the number and duration of contact with the odor, mouth openings, vocalizations (air only) and air bubble production (water only). Our results, although limited by the low number of animals monitored (n = 5), suggest that California sea lions responded strongly to some odors, especially to food and social odors (except for the carnivore), both in the air and under water. Furthermore, in the aerial environment, vocalizations were produced only in response to food odors. In the aquatic environment, the process allowing the perception of odors remains to be characterized. Applications to this work could be considered in captive conditions, for instance to reduce the stress of the animals in certain situations, as well as in the wild, to limit their impact on fisheries, experienced as very negative by fishermen.

Developing and evaluating enhanced photo-identification techniques using a long-term common bottlenose dolphin (Tursiops truncatus) catalog.

Amy Brossard¹, Lynsey Wilcox², Patricia Rosel³, Jenny Litz⁴, Joseph Contillo⁵, Jesse Wicker⁶

¹Cooperative Institute of Marine Atmospheric Studies, NOAA SEFSC MMTD Affiliate, Big Pine Key, FL, ²NOAA Fisheries, Southeast Fisheries Science Center, Lafayette, LA, ³NOAA Fisheries, Lafayette, Louisiana, ⁴Marine Mammal and Turtle Division, SEFSC, NOAA Fisheries, Miami, Florida, ⁵NOAA, SEFSC, Miami, FL, ⁶Cooperative Institute for Marine and Atmospheric Studies (CIMAS), NOAA Affiliate, Miami, FL

Traditional photo-identification methods of common bottlenose dolphins (Tursiops truncatus) identify individuals using natural markings along the margins of the dorsal fin. However, drastic changes to the fin can occur abruptly, rendering the fin unrecognizable. In addition, gaps in survey effort allow more time for alterations to accumulate leading to misidentification of individuals, which negatively impacts estimates of population parameters. This study provides a retrospective assessment on the use of persistent scar patterns and genetic analysis to supplement traditional methods for detecting fin changes and misidentification errors. An audit of individual sighting histories was conducted of the Biscayne Bay, Florida bottlenose dolphin catalog (1990-2018) which included 319 individuals. In cases where past identification errors were suspected, raw, uncropped images were evaluated for the presence of persistent unique scar patterns (e.g., shark bites, prop scars, entanglement scars). These scars were used to confirm or reject suspected misidentifications. The audit revealed 23 false negative (FN) (the same animal cataloged twice) and four false positive (FP) errors (different animals falsely matched). Scar patterns were useful for confirming the misidentifications in more than half of the cases (57% FN and 50% FP). Additionally, 12 marked individuals unmatched based on dorsal fins alone were able to be matched based on scar patterns. Previously collected skin biopsies (n = 85) were genotyped at 19 microsatellite loci and revealed
11 individuals that were biopsied more than once. Two had not been identified as duplicate biopsies from the dorsal-fin analysis. However, matching the scar patterns confirmed the duplication. Results indicate that integrating body scar patterns into our catalog audit improved the detection of dorsal fin changes over time and reduced the likelihood of identification errors. In the future, altering field and photo-processing methods to include the examination of scar patterns could reduce catalog errors.

**Old news is good news! Historic newspaper archives offer insight into changes in large whale species composition in the New York Bight**

Danielle Brown\(^1\), John Wiedenmann\(^2\)

\(^1\)Rutgers University, Neptune City, New Jersey, \(^2\)Rutgers University, New Brunswick, NJ

The recovery of large whales from commercial whaling can be difficult to measure without baseline data. In the North Atlantic, consistent data collection has only taken place in the last 50 years, and less is known of species composition and distribution prior to that time. Log books from commercial whaling vessels can provide insight into when and where certain species were caught, but in areas where primarily shore whaling took place, records are often incomplete. One example is in the New York Bight (NYB), part of the northeastern United States. Shore whaling did take place here, but formal records are limited and those that exist often do not mention the species. However, large whale sightings and strandings made headlines in local newspapers. The digitization of historic newspaper archives provides a unique alternative for accessing and analyzing these reports. An apparent increase in humpback whales in the NYB over the last decade may suggest that recovering species are returning to this area that was previously occupied. To investigate this hypothesis, I examined temporal trends in species composition by searching for whale reports in 39 digital newspaper archives. From 1821-1940, right whales (Eubalaena glacialis), fin whales (Balaenoptera physalus), and sperm whales (Physeter macrocephalus) were the primary species reported. There was a decline in the number of overall whale reports during 1941-1980, and from 1981-2020 humpback whales and fin whales were the dominant species. Throughout the study period, there were also limited numbers of blue whale (Balaenoptera musculus), minke whale (Balaenoptera acutorostrata), and gray whale (Eschrichtius robustus) reports. Species composition appears to have changed over time, with humpback whales likely uncommon prior to 1980. Although not the preferred source of data, these opportunistic reports offer insight into the historic ecology of large whales in the NYB that would otherwise be difficult to obtain.

**Documented early-stage entanglements of North Atlantic right whales (Eubalaena glacialis) in the southern Gulf of Saint Lawrence, Canada**

Moira Brown\(^1\), Delphine Durette-Morin\(^2\), Kelsey Howe\(^3\), Gina Lonati\(^4\), Marianna Hagbloom\(^4\), Amy Warren\(^4\), Hansen Johnson\(^2\), Meg Carr\(^5\), Nick Hawkins\(^6\), Amy Knowlton\(^7\), Kimberley Davies\(^8\), Stephane Ferron\(^9\), Martin Noël\(^10\)

\(^1\)Canadian Whale Institute/Campobello Whale Rescue Team, Wilsons Beach, New Brunswick, \(^2\)Dalhousie University, \(^3\)Anderson Cabot Center for Ocean Life at the New England Aquarium, Somerville, MA, \(^4\)University of New Brunswick Saint John, Franklin Lakes, NJ, \(^5\)Dalhousie University, Halifax, NS, \(^6\)Nick Hawkins Photography, Halifax, Nova Scotia, \(^7\)Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, MA, \(^8\)University of New Brunswick, Saint John, New Brunswick, \(^9\)Équipe de Désempêtrement du Golfe, Shippagan, New Brunswick, \(^10\)Association des Pêcheurs Professionnels Crabiers Acadiens (APPCA), Shippagan, New Brunswick

The early-stage entanglement of North Atlantic right whales (Eubalaena glacialis) in the southern Gulf of Saint Lawrence, Canada, was a concern for conservationists and local communities. Moira Brown and her team documented 31 incidents of entanglement in the southern Gulf of Saint Lawrence from 2016 to 2020. These incidents highlighted the importance of understanding the distribution and behavior of these whales to prevent future entanglements.
At least 86% of North Atlantic right whales (*Eubalaena glacialis*) have been documented with entanglement scars. Most of these individuals have never been observed with attached gear, suggesting that many of these whales may “shed” entangling ropes, but at what cost? Using vessel and drone-based photographs and video, we describe two instances during which circumstances indicate the whales were reacting to new or recent entanglements. On July 13th, 2021, a 5-year-old male right whale (#4615) was observed at 12:05 in the southern Gulf of Saint Lawrence (sGSL), Canada, without evidence of entanglement. At 16:30 the same day, #4615 was observed with gear through his mouth and four body and peduncle wraps. The whale was repeatedly thrashing its tail and had severe, open wounds on the peduncle and the fluke’s leading edge. During the next six hours of prolonged thrashing behavior, the gear shifted on the whale’s body and a telemetry buoy was attached to the trailing line. The whale was observed the next morning with only one rope through its mouth, no telemetry buoy, and has not been observed since.

On August 20th, 2018, at 17:49, a 9-year-old male right whale (#3960) was observed entangled in the sGSL, with multiple head and body wraps. Only fourteen days earlier, #3960 had been seen without gear. Similar to #4615, the animal’s behaviour was very violent, including tail slashes and spiraling dives. He had extensive bleeding injuries on the tailstock and damaged baleen. During the next hour and a half, the gear shifted numerous times on the whale’s body. He then travelled away quickly, gear free. He has been seen in subsequent years with healing wounds. These shocking events are but two examples showing the stress and energetic costs, in addition to the physical wounds, these animals must undergo when faced with an entanglement.

**Conservation implications of the first large scale abundance estimates for botos and tucuxis in Central Amazon**

Sannie Brum1, Vera da Silva2
1National Institute for Amazonian Research - INPA, Manaus, Amazonas, Brazil, 2Instituto Nacional de Pesquisas da Amazônia - INPA, Manaus, Amazonas, AM, Brazil

The boto *Inia geoffrensis* and the tucuxi *Sotalia fluviatilis* are threatened mainly by interactions with fishing activities. In the last 20 years, the use as bait, mainly of the boto, in the fishing of the catfish piracatinga has caused special concern. We (i) estimate the abundance of botos and tucuxis in two of the most used rivers for fishing in Central Amazonia, and (ii) identify our power to detect population trends from these estimates. Boat-based surveys were carried out in 625 km in the Solimões River, and 732 km in the Purus River. To estimate abundance, we used the *Mark Recapture Distance Sampling* framework. To detect the power to identify population trends, we applied the *Gerrodette inequality* model. In the Solimões River (3,766 km²), we estimated 6,026 botos (CV=0.22; CI95% 4,143- 9,415; density=1,6) and 11,675 tucuxis (CV=0.14; CI95% 9,038-15,817; density=3.1). In the Purus River (917 km²), we estimated 9,170 botos (CV = 0.12; CI95% 7,336-11,646; density=10.0) and 7,244 tucuxis (CV=0.16; CI95% 5,135-10,270; density=7.9). Based on the smallest population and the highest CV, it will be necessary 43 years of annual expeditions to detect a population trend indicating that these species are threatened according to the IUCN criterion; and 12 years to identify declines following the currently published decline taxa. The densities found of both species in the Purus River are the highest ever reported, identifying this region as an important area for these species conservation. Sole abundance estimates contributes little to infer anthropic impacts on these dolphins population, although these are now baseline for monitoring. Our analysis proved to be adequate, reducing the high CVs commonly published for these species abundances, but power to detect population trends is extremely low. As so, different monitoring approaches should be
considered and the precautionary principle applied regarding management of piracatinga fishing.

**Status of ringed, bearded, spotted, and ribbon seals in Alaska using harvest-based monitoring across decades: 1960s, 1970s, 2000s, and 2010s**

Anna Bryan¹, Lori Quakenbush², Justin Crawford², Justin Olnes³, Ryan Adam, John Citta³ ¹Alaska Department of Fish and Game, ²Alaska Dept. Fish and Game, Fairbanks, Alaska, ³Alaska Department of Fish and Game, Fairbanks, Alaska

Ice-associated seals (ringed, *Pusa hispida*, bearded, *Erignathus barbatus*, spotted, *Phoca largha*, and ribbon, *Histriophoca fasciata*), important subsistence resources for Alaska Natives, are expected to be negatively affected by sea ice decline by reducing available habitat and their time to rest, rear pups, and molt on sea ice. Current demographic data are insufficient for detecting trends in abundance; however, data from the subsistence harvest can be used as indices of population status. We compared seal indices collected during the current ice decline (2000s and 2010s) with those collected prior to the decline (1960s and 1970s). Indices included length at age (growth), blubber thickness (body condition), pregnancy rate (productivity), and proportion of pups harvested (pup survival to weaning). During the 2010s as sea ice declined, seal growth and blubber thickness were typically average or above. Below average years for both indices were often followed by average or above average years. Pregnancy rate during the 2010s was higher for bearded and spotted seals than during the earlier periods; no periods were statistically different for ringed or ribbon seals. The average age of maturity (age at first ovulation) for bearded seals decreased over time to 2.8 years in the 2010s. In contrast, age of maturity for ringed (3.7) and spotted (3.3) seals in the 2010s was similar to the 1960s and 2000s and lower than the 1970s. Finally, a relatively high proportion of pups were harvested in the 2010s indicating that pups were produced, weaned, and survived to be harvested. Several of our indices decreased in 2010 and 2011, coinciding with the Unusual Mortality Event, but were followed by a return to average in 2012. Overall, our indices have not shown sustained decreases in growth, body condition, productivity, or pup survival as predicted with declining sea ice that would be indicative of population declines.

**First Documented Use of Caves along the Coast of Albania by Mediterranean Monk Seals. Ecological and Conservation Inferences**

Luigi Bundone¹, Gema Hernandez-Milian¹, Nexhip Hysolakoj¹, Rigers Bakiu², Tatjana Mehilla², Lorela Lazaj², Amy Lusher², Giulio Pojana² ¹Archipelagos - ambiente e sviluppo, Italia, Venice, Italy, Italy, ²Agricultural University of Tirana, Faculty of Agriculture and Environment, Department of Aquaculture and Fisheries, Tirana, Albania

The information on habitat use by the Mediterranean monk seal (*Monachus monachus*) on the coast of Albania has so far been limited to vague and general data. During a survey conducted along the coast of the National Marine Park Karaburun-Sazan in August 2019, we identified two marine caves with optimal geomorphological characteristics for use by the species. A monk seal scat was recovered in one of them. These two caves were subsequently equipped with infrared cameras. After about a year of monitoring, we obtained photographic material confirming such use. This is the very first documentation of the use of marine caves by the species in Albania. The scat sample was analysed for trophic and anthropogenic contamination (microplastics) data. The inferences resulting from the analyses of the above data provide additional information on the
ecology of the species and also for its conservation which need to be contextualized on an Adriatic-Ionian region scale.

Using GIS to pinpoint hot spots of cetacean strandings in Peru: A 10 year review
Lydia Bunn¹, Carlos Francisco Yaipen-Llanos²
¹Organization for Research and Conservation of Aquatic Animals - ORCA PERU-, Surco, Lima, Peru, ²Organization for Research and Conservation of Aquatic Animals - ORCA PERU, Surco, Lima, Lima, Peru

Conservation efforts for cetaceans are limited due to the lack of knowledge of their distribution and abundance, and gaining this information is challenging as cetaceans are highly mobile and often elusive. Long-term data from stranding networks can offer spatial, temporal and demographic trends on species richness, diversity and mortality. Here, we collate a long-term data set from ORCA’s Stranding Network in Peru from 2009 to 2019 to map stranding hot-spots on the coast of Peru. Over 10 years, there were 286 stranding events across 22 different cetacean species, comprising 90% small cetaceans and 10% large cetacean. The most recorded species were Phocoena spinipinnis (n=71), Tursiops truncatus (n=50), Delphinus delphis (n=45), and Lagenorhynchus obscurus (n=44), meanwhile Megaptera novaeangliae (n=15) was the most common large cetacean. The majority of strandings were caused by human factors (65 %), with 43 % of the strandings caused by direct intentional catch. There were three stranding hotspots: Wakama, Lambayeque and South of Lima City, which had an overall density of 86 strandings per 50 Km. We used the raster calculator to show the density changes between 2009 and 2019. The results showed no significant changes in the spatial trend. However, there was a slight decrease in density around Wakama and an increase around North and South Lima. Our results improve the understanding of spatial-temporal patterns of cetacean diversity on the Peruvian coast. The use of small cetaceans for consumption and bait is common practice in Peru, though it has been banned since the mid-1990s. Yet, our data shows small cetacean capture at high levels, which calls for urgent action. For example, Phocoena spinipinnis, the most commonly stranded species, is listed as threatened under the IUCN, causing concern for their population in Peru. Furthermore, these results are vital information for management plans, targeted surveys and community-led action.

One year later: Demographic changes at a Steller sea lion rookery following a volcanic eruption on Raykoke Island, Russia.
Vladimir Burkanov¹, Russel Andrews², Thomas Gelatt³
¹Marine Mammal Laboratory, AFSC, NMFS, NOAA, Seattle, Washington, ²Marine Ecology and Telemetry Research, Kingston, WA, ³NOAA Alaska Fisheries Science Center, Marine Mammal Laboratory, Seattle, Washington

After sitting quiet for nearly 100 years, the Raykoke Island volcano, in the Kuril Islands of Russia, erupted violently on 22 June 2019, near the peak of the Steller sea lion (SSL) pupping season. Volcanic ash blanketed the Raykoke SSL rookery several meters deep, and volcanic debris extended the coastline seaward for tens to hundreds of meters, presumably killing all newly-born pups, and probably many non-pups. The rookery had been located in a steep area of old lava but was transformed into something akin to a lunar surface with a low angle slope formed by gray volcanic ash. No SSLs were observed around the former rookery area during two visits to the island in July and September 2019. Observations in the summer of 2020 revealed that winter storms had washed off much of the volcanic ash from the rookery area, exposing the outer edge of old solid lava substrate. On 18 June 2020 we found 24 newly-born pups and 140 non-pups on the rookery (69 females, 56 bulls, 10
subadult males, and 10 SSL that could not be aged or sexed due to poor visibility). Prior to the eruption females accounted for a larger proportion (65-75%) of non-pups during the breeding season. On 12 July 2020 we observed 56 live pups (plus 2 dead) and 119 non-pups (66 females, 27 bulls, and 25 unknown SSLs in the water). Compared with the latest pre-eruption survey on 09 July 2018 the total non-pup number declined by 65%; females declined by 69%, juveniles by 97%, and pups by 60%. The greater proportional reduction in females in June 2020 and concurrent decrease in other age/sex groups on the Raykoke Island rookery was likely caused by the 2019 volcano eruption which may have affected survival and natality through increased mortality.

Accumulation of Heavy Metals and Metalloids in Northern Sea Otter Vibrissae (Enhydra lutris kenyoni)
Kayli Burke1, Dimitrios Giarikos2, Verena Gill1, Lori Polasek4, Amy C. Hirons5
1Nova Southeastern University, 2Nova Southeastern University, Ft. Lauderdale, 3NOAA Fisheries, Anchorage, Alaska, 4Alaska Department of Fish and Game, Junea, Alaska, 5Nova Southeastern University, Dania Beach, FL

Northern sea otter (Enhydra lutris) populations of Alaska have seen significant declines since the 1970s with some regions, such as southwestern Alaska, seeing more declines than southcentral or southeast Alaska. Heavy metals are naturally and anthropogenically sourced, potentially arising anywhere from volcanic eruptions to mining remnants, both prevalent in Alaska. These trace elements are known to have toxic effects in humans, but toxic concentrations are unknown in sea otters. Preliminary analysis for twelve heavy metals, including arsenic, cadmium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, vanadium, and zinc, were analyzed in vibrissae (whiskers). Why whiskers? Whiskers are continuously growing, inert, keratinous tissue that individually provide approximately a one-year timeline of heavy metal acquisition via diet. As predominant benthic foragers, the sea otter diet consists primarily of marine invertebrates, such as various molluscs and crustaceans, sea urchins, and some species of fish, most of which bioaccumulate heavy metals. Whisker samples (n>200) were collected from 1994-2014 from all three Alaska regions; eighteen (10 males, 8 females) subadult/adult sea otters from southcentral Alaska have been analyzed to date. The only trace elements to show significant concentrations thus far include cadmium, chromium, vanadium, and zinc. Cadmium, a nonessential metal, was found to have the lowest concentration (0.00-2.54 ppm) but it can be toxic even at low concentrations. On average, northern sea otter vibrissae had the highest concentrations of chromium (0.00-2295.36 ppm), vanadium (0.00-1278.83 ppm), and zinc (29.31-696.61 ppm), all of which are considered essential metals. The preliminary sample size is not currently robust enough to establish statistical differences among the three regions; however, regional differences in heavy metal concentrations are expected and may contribute to the disproportionate population sizes among the three regions.

The efficacy of management measures to reduce vessel noise in critical habitat of southern resident killer whales in the Salish Sea
Rianna Burnham1, Svein Vagle2, Caitlin O’Neill3, Krista Trounce4
1Fisheries and Oceans Canada, Victoria, British Columbia, 2Fisheries and Oceans Canada, Sidney, 3Fisheries and Oceans Canada, Sidney, BC, 4Vancouver Fraser Port Authority

Key threats to endangered southern resident killer whales (SRKW, Orcinus orca) include physical and acoustic disturbance and strikes from vessels. Critical habitat designated in the Salish Sea, the inland waters of southern British
Columbia and northern Washington State, experiences high rates of commercial and recreational vessel traffic, yet SRKW forage here during summer months. We describe the efficacy of conservation measures aimed at reducing acoustic impacts during this time. Trial periods were compared to a two-month baseline, with changes in ambient noise (10Hz-100kHz) and SRKW communication (500Hz-15kHz) and echolocation (15-100kHz) frequency ranges considered. Voluntary participation in slowdown and vessel rerouting measures were high, whereas the avoidance of enforced exclusion zones in important SRKW foraging areas was low. Inputs from vessel noise were determined by examining periods when natural ambient noise in the recordings was minimized, when sea state was low, wind speeds were less than 10 km/h, and tide was slack. The slowing of commercial vessels reduced noise levels predominantly in the low frequencies, yet in Boundary Pass median speed reductions of 3.5 knots resulted in a 3.5 dB decrease in the echolocation range. A vessel displacement measure, focused on tugs and barges, aimed at moving vessel transits away from SRKW foraging areas, showed each modified transit to have the potential to significantly reduce broadband noise additions, in the order of 4-7 dB. Exclusion zones have shown the least compliance, especially from recreational vessels. However, significant reductions in ambient and SRKW-relevant frequencies were seen for all trial areas. Effectual mitigation measures are needed to reduce the impact of vessel noise which can hinder navigation, communication, and prey location for foraging whales. Establishing the participation rate, and the resulting changes in the sound field as a result of mitigation measures will help refine these to be more effective in future years.

Rolling in the deep – does red pelage coloration in grey seal females (Halichoerus grypus) reflect diet or foraging habitat? Jennifer Burns¹, Michelle Shero², Cheryl Clark¹, Damian Lidgard⁴, Nell den Heyer³, Greg Breed⁶ ¹Texas Tech University, Lubbock, Texas, ²Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, ³Texas Tech University, Lubbock, TX, ⁴Dalhousie University, Halifax, Nova Scotia, ⁵Bedford Institute of Oceanography, Dartmouth, Nova Scotia, ⁶University of Alaska, Fairbanks

Many coastal seal species include individuals with red or rust pelage coloration, attributed to direct contact with iron oxide/hydroxide that binds with keratin in the hair shaft. Because the red coloration occurs most often around the head and muzzle, “redheads” are assumed to forage on benthic prey found in/on iron-rich substrates. However, it remains unknown whether this visible signal of foraging habitat represents broad scale differences in diet and foraging site selection (i.e., only some benthic foragers target prey species in habitats rich in iron oxide). To address this question, we used stable isotope (SI) analysis of blood and vibrissae to compare diet between 10 adult grey seal females with red tinged fur to that of 10 seals of normal pelage coloration. Many of the redheaded females had rostral and supraorbital whiskers and facial fur that were notably abraded, suggesting that they focused their foraging more exclusively in the benthos than did their less colorful, but more hirsute, conspecifics. Foraging in iron rich substrates may provide redheads with additional iron intake through direct and/or indirect ingestion. To eliminate the possibility that vibrissae and fur loss was due to iron toxicity, we compared serum iron and ferritin levels between groups, and assessed a suite of hematological parameters associated with iron intake and health (hematocrit, hemoglobin, mean corpuscular hemoglobin concentration, white blood cell, red blood cell, and reticulocyte counts). Slightly elevated iron intake rates may be advantageous during critical life history events such as lactation, when females transfer significant iron
to their pups. Individuals that forage in iron-rich benthic environments may be able to maintain higher endogenous heme stores and thus specialization in diet may have important implications for aerobic dive capacities.

Modelling the Energetic Consequences of State-Dependent Responses to Anthropogenic Disturbance Highlights Key Data Gaps for Marine Mammal Conservation

Alec Burslem¹, Saana Isojunno², Enrico Pirotta³, Patrick Miller⁴
¹Sea Mammal Research Unit, University of St Andrews, Leuchars, Fife, United Kingdom, ²Sea Mammal Research Unit, University of St Andrews, St Andrews, Fife, United Kingdom, ³University of St Andrews, St Andrews, Scotland, United Kingdom, ⁴Sea Mammal Research Unit, School of Biology, University of St Andrews, St Andrews, Fife, United Kingdom

Lipid store body condition is fundamental to how animals cope with environmental fluctuations, including anthropogenic change. As it provides an energetic buffer, body condition is expected to influence risk-taking strategies, with both positive and negative relationships between body condition and risk-taking posited in the literature. Individuals in good condition may take more risks due to state-dependent safety (“ability-based” explanation), or alternatively less risks due to asset protection and reduced need to undertake risky foraging (“needs-based”). Such state-dependent responses could drive non-linear impacts of anthropogenic activities through feedback between body condition and behavioural disturbance. Here, we present a simple bioenergetic model that explicitly incorporates hypothetical body condition-dependent response strategies for a cetacean, the sperm whale. The model considered the consequences of state-dependent foraging cessation and availability of wax ester (WE) lipids for calf provisioning and female survival. We found strikingly different consequences of disturbance depending on strategy and WE availability scenarios. Compared to the null strategy, where responses to disturbance were independent of body condition, needs-based strategy mitigated predicted reductions in provisioning by 10-13%, while the ability-based strategy exaggerated reductions by 63-113%. Lower WE availability resulted in more extreme outcomes because energy stores were smaller relative to the daily energy balance. In the 0% availability scenario, while the needs-based strategy reduced deaths by 100%, deaths under the ability-based strategy increased them by 335% relative to null and by 56% relative to the same strategy under the 5-6.7% WE availability scenario. These results highlight that state-dependent disturbance responses and energy store availability could substantially impact the population consequences of disturbance. Our ability to set appropriate precautionary disturbance thresholds therefore require empirical tests of ability- vs needs-based response modification as a function of body condition and a clearer understanding of energy store availability.

Wearable near-infrared spectroscopy as a physiological monitoring tool for seals under anaesthesia

Eva-Maria Bonnellycke¹, Gordon Hastie², Kimberley Bennett³, Jana M. Kainerstorfer⁴, Ryan Milne⁵, Simon Moss⁶, Alexander Ruesch⁴, Jingyi Wu⁴, J. Chris McKnight⁷
¹University of St. Andrews, St. Andrews, United Kingdom, ²Sea Mammal Research Unit, St Andrews, ³Abertay University, Dundee, United Kingdom, ⁴Carnegie Mellon University, Pittsburgh, Pennsylvania, ⁵Sea Mammal Research Unit, St. Andrews, ⁶Sea Mammal Research Unit, St. Andrews, United Kingdom, ⁷Sea Mammal Research Unit, Antrim

Chemical immobilisation of pinnipeds is a routine procedure in research and veterinary practice. Yet, there are inevitable risks associated
with chemical immobilisation, and the physiological response to anaesthetic agents in pinnipeds remains poorly understood. Wearable near-infrared spectroscopy (NIRS) systems provide real-time non-invasive measurements of haemodynamic changes and oxygenation within specific tissues. The current study used existing continuous-wave NIRS data from 10 trials of prolonged anaesthesia induced through ketamine and midazolam in 5 grey seals (Halichoerus grypus). The aim of this study was to (1) analyse the effect of each compound on heart rate, arterial oxygen saturation (SpO₂), and relative concentration changes in oxygenated [ΔO₂Hb] and deoxygenated haemoglobin [ΔHHb] in cerebral tissue and (2) to use these findings to determine whether NIRS could provide real-time physiological monitoring to alleviate potential risks under anaesthesia. The timings of intravenous drug administrations were extracted from video analysis. Average group responses of ketamine (n=27) and midazolam (n=11) administrations were modelled using generalised additive mixed models (GAMM) for each dependent variable. Following ketamine and midazolam administration, [ΔHHb] increased and [ΔO₂Hb] remained relatively stable, which was indicative of the cerebral response to apnoea. Given that SpO₂ remained at 97% during apnoea, we hypothesized that increasing [ΔHHb] was a result of venous congestion as opposed to decreased oxygen delivery. Changes in heart rate were limited and appeared to be driven by the individual pharmacological actions of each drug. The reported changes for each dependent variable represent limits within which safe recovery from anaesthesia is expected. Beyond these limits, additional measures of metabolic function are needed to assess whether venous congestion under prolonged periods of apnoea could compromise cerebral integrity. Our findings support the use of NIRS as real-time physiological monitoring tool during pinniped chemical immobilisation, which could assist veterinarians and researchers in performing safe chemical immobilisation procedures.

Toxoplasma gondii molecular and serological survey in Amazon river dolphins (Inia geoffrensis), tucuxi (Sotalia fluviatilis), and Amazonian manatees (Trichechus inunguis) in the Western Brazilian Amazon

Thaís C S Rodrigues¹, Flávia França¹, André Luiz Santos¹, Vanessa dos Santos¹, Tiago Mineo², Miriam Marmontel³

¹Federal University of Uberlândia, ²Laboratory of Immunoparasitology “Dr. Mário Endsfeldz Camargo”, Department of Immunology, Institute of Biomedical Sciences, Federal University of Uberlândia, ³Instituto Mamirauá, Tefé, Amazonas, Brazil

Amazonian manatees (Trichechus inunguis), Amazon river dolphins (Inia geoffrensis), and tucuxis (Sotalia fluviatilis) are aquatic mammals endemic to the Amazon Basin, classified by the International Union for Conservation of Nature as Vulnerable, Endangered, and Endangered, respectively. Although Toxoplasma gondii is recognized as an important pathogen in marine mammal conservation and highly prevalent in the Amazonian environment, little is known about infection in Amazonian aquatic mammals. The present study was designed to investigate the presence of T. gondii DNA in tissue samples of Amazonian cetaceans using a real-time polymerase chain reaction assay, and seroprevalence of anti-T. gondii antibodies in Amazonian manatees by indirect haemagglutination test. We provide the first reports of molecular identification of T. gondii in heart samples of Amazon river dolphins and in the heart and brain samples of a tucuxi. Evidence of T. gondii infection in tucuxis had never been reported. Anti-T. gondii antibodies were present in 35% of the Amazonian manatees. Although most samples presented low titers (1:8 and 1:16), one wild manatee presented a 1:64 titer, which is the cut-off titer for serological survey of toxoplasma infection in domestic animals. Our study provides novel evidence of infection by T.
Aquatic mammals from the Amazon and Orinoco regions of Colombia using environmental DNA (eDNA): detection success and potential as a population monitoring tool.

Susana Caballero¹, Rita Daniela Martinelli², Carlos Lasso³

¹Universidad de los Andes, ²Universidad de los Andes, Bogota, Colombia, ³Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Bogota, Colombia

Colombia is one of the most biodiverse countries in the world, with ecosystems such as rainforest and neotropical savannas crossed by rivers in the Amazon and Orinoco regions. Aquatic mammals have been studied in these areas using methods like direct observation and identification of...
fecal/food remains. These can be time consuming and expensive. In this study, we tested the use of environmental DNA to detect aquatic mammals in the Amazon and Orinoco regions of Colombia. Water samples (1-3 liters) were collected in rivers and lakes from two points in Serranía de la Macarena (Meta province, Orinoco region), 12 points around Bojonawi reserve (Vichada province, Orinoco region), 11 points around Puerto Nariño (Amazonas province, Amazon region) and in two points along the Caqueta River (Caqueta province, Amazon region). Samples were filtered using manual filters (0.8 um). DNA was extracted and a 110 bp of the 12s mitochondrial DNA was amplified and sequenced in an Illumina HiSeq at NatureMetrics in the UK. DNA sequences (reads) were compared with public databases for taxonomic assignment. We obtained Amazon river dolphin reads (Inia geoffrensis geoffrensis) in two points around Puerto Nariño (average read percentage, ARP=50%) and Orinoco river dolphin reads (Inia geoffrensis humboldtiana) in three points in Bojonawi reserve (ARP=82%) and in one point from Serrania de la Macarena (ARP=14%). Tucuxi dolphin reads (Sotalia fluviatilis) were detected in one point around Puerto Nariño (ARP=1.5%) and Giant River otter reads (Pteronura brasiliensis) were found in one point of the Bojonawi reserve (ARP =17%). We did not detect either Amazonian manatees (Trichechus inunguis) nor Antillean manatees (Trichechus manatus). This is the first study of this type in the Colombian Amazon and Orinoco and this technique may be used for population monitoring purposes and for citizen science projects with participation of local communities.

Evidence-based medicine as support in rescue and rehabilitation processes of manatees in the Caribbean

Lesly J. Cabrias-Contreras¹, José E. de Angel², Carla Ivette Rivera-Perez³, Michelle M. Dennis⁴, Sylma Maria Escobar-Torres⁵, Ricardo Fernández-Martinez⁵, Edward Hernandez⁵, Antonio L. Rivera-Guzman⁶, Pedro J. Rivera-Illarraza⁵, Antonio Mignucci⁶

¹Puerto Rico Manatee Conservation Center, ²Caribbean Manatee Conservation Center, San Juan, Puerto Rico, Puerto Rico, ³Ross University School of Veterinary Medicine, San Juan, Puerto Rico, ⁴University of Tennessee, Knoxville, Tennessee, ⁵Inter-American University of Puerto Rico/Puerto Rico Manatee Conservation Center, Puerto Rico, ⁶Caribbean Manatee Conservation Center, Bayamón, Puerto Rico, Puerto Rico, ⁷Caribbean Manatee Conservation Center, Cataño, PUERTO RICO, Puerto Rico, ⁸Puerto Rico Manatee Conservation Center, San Juan, PR, ⁹Manatee Conservation Center, Bayamon, Puerto Rico

Manatees are endangered primarily due to anthropogenic causes. Alongside naturally-occurring diseases, these are the main reasons why manatees enter rescue and rehabilitation programs. The veterinary care process begins from the moment of rescue, offering a comfortable, stress-free transport, monitoring their vital signs, supplementing oxygen, and providing fluid therapy in order to stabilize the animal until they arrive at the marine hospital. Once at the Center, the patients are further assessed through hematological and blood chemistry tests to determine how they are systemically. Depending on the reasons for admission, varied diagnostic and therapeutic methods are implemented, including radiology, ultrasound, coprology, ophthalmological examinations, cultures, cytology, thermography, virology, histopathology, nebulization, and the use of comprehensive and advanced wound management techniques. The therapeutic strategies currently being implemented consist of attacking the different pathologies through different approaches and not locally as previously done. For this reason, management is carried out by controlling all factors that could influence the health of the patient during the
rehabilitation processes, i.e., environmental, local, systemic, and nutritional level factors. A zootechnical approach is used with nutritional supplementation based on vitamins, minerals, and nutraceuticals. The feeding of these patients is constantly evaluated by morphometrics and implementing caloric calculations that establish feeding schemes in calves based on milk formulas that seek to promote growth simultaneously for muscle and fat tissue. For weaned manatees and adults, diets are based leafy greens, together with, fruits, grasses, and aquatic plants that provide variety and nutritional needs. The rehabilitation process also focuses on strengthening the patient’s mental health and well-being under human care, offering varied environmental enrichment that allows cognitive development, minimizing stress, and strengthening tactile stimuli. This evidence-based medicine allows for a more effective and efficient process during medical care and rehabilitation, yielding better survival rates for patients when they go back to the wild.

Lunch time: What might diet exploration of the endangered St. Lawrence Estuary beluga population reveal during a period of ecosystem and demographic change (1988—2020)?

Jory Cabrol1, Veronique Lesage2
1Fisheries and Oceans Canada, Mont-Joli, Quebec. 2Fisheries and Oceans Canada, Mont Joli, Quebec

Over the past decades, the community structure of northern ecosystems has changed due to natural and anthropogenic factors. In light of the recent decline of the endangered St. Lawrence Estuary (SLE, Canada) beluga population, it is hypothesized that these changes have resulted from reduced prey availability/quality, with consequences on beluga feeding strategies and physiological condition. We used stable carbon and nitrogen isotope ratios from 201 SLE beluga found dead from 1988—2020, and 17 of their potential prey, to assess how their diet changed over this period. Specifically, we examined diet in relation to resource availability, and changes in trophic niche and degree of specialization both at the individual and population levels. Diet estimates from mixing models indicate a change in diet around 2000 after a period of relative stability, which coincided with an environmental shift toward warmer conditions and relatively low prey biomasses compared to the 1990’s. Niche metrics revealed a diversification of diet over time at the population level, mostly as a result of an increase in interindividual variability in resource selection. These changes were more striking in ~10 to 40 years-old adult males than females. Considering the sex-segregation documented in beluga during summer and possibly other times of the year, these results likely indicate a differential exposure to ecosystemic change. Males generally occupy deeper and more marine/offshore areas compared to females, and feed to a larger extent than females on demersal fish in the SLE. While some of these stocks (e.g., Atlantic cod) have collapsed in the 1990s and not recovered, others (e.g., redfish) have rebounded in recent years and may have benefited adult males more than females. These findings emphasize the importance of considering individual-specific as opposed to only population average responses when assessing the resilience of generalist feeders such as SLE beluga.

Size-selective predation by Antarctic humpback whales

David Cade1, Shirel Kahane-Rapport2, Ben Wallis2, Jeremy Goldbogen2, Ari Friedlaender2
1Stanford University, 2Hopkins Marine Station, Stanford University, Pacific Grove, CA, 3Ocean Expeditions, 4Stanford University, Pacific Grove, CA, 5University of California Santa Cruz, Santa Cruz, California

Animals aggregate around resource hotspots, but what makes one resource more appealing than
another is difficult to determine, particularly when the scales of data collection differ from those of animal behavior. These challenges can obscure heterogeneity in a prey field that explains predator aggregation and species distributions. We used suction-cup attached biologging tags and active acoustic prey mapping to investigate humpback whale foraging behavior and prey characteristics in two Antarctic Peninsula fjords. Though geographically proximate, Charlotte Bay contained ~5x more whales than Wilhelmina Bay, a site previously known for super aggregations of whales and krill, inspiring our hypothesis that whale abundance is linked to prey biomass. Interestingly, we find that patch size and krill length at the depth of foraging better predict foraging effort than biomass. Tagged whales spent > 80% of the night foraging, and whales in both bays demonstrated similar nighttime feeding rates (48.1 ± 4.0 vs 50.8 ± 16.4 lunges/hr). However, whales in Charlotte Bay foraged for 58% of their daylight hours, compared to 22% in Wilhelmina Bay, utilizing deep (280-450m) foraging dives in addition to surface feeding strategies like bubble-netting. Daytime krill biomass density peaked between 200-300m depth, but patch size and krill size both increased below 300m, coincident with observed foraging depths. Large, mature, lipid-rich krill have previously been observed at these depths, likely feeding on detritus while avoiding predators. Selective foraging on larger krill by humpback whales has not been previously determined, but suggests hierarchical decision making to target more desirable parts of high-quality foraging environments. This behavior may be partially attributable to prey availability in an ecosystem from which baleen whales were nearly extirpated. More research utilizing a suite of techniques, including the dB differencing approach described here, is necessary to better characterize the ubiquity of size-selective foraging by baleen whales.

Long Term Trends in Gray Whale Stranding in Washington State: Insights from Consistent Responses from 1977-2022 Including Connections with Unusual Mortality Events

John Calambokidis1, Jessie Huggins2, Dyanna Lambourn1, Stephanie Norman1, Steven Jeffries3, Kristin Wilkinson1, Amanda Warlick3, Deborah Duffield4, Stephen Raverty5

1Cascadia Research Collective, Olympia, 2Cascadia Research Collective, Olympia, Washington, 3Washington Department of Fish and Wildlife, Olympia, Washington, 4na, 5Washington Department of Fish and Wildlife (retired), Lakewood, Washington, 6NOAA Fisheries, Protected Resources Division, Seattle, Washington, 7University of Washington, Seattle, 8Portland State University, Portland, OR, 9The Animal Health Center, Abbotsford, British Columbia

Eastern North Pacific gray whales migrate past Washington State between their primary feeding grounds in the Arctic and winter breeding areas in Mexico. Washington is also used more extensively by a smaller group of whales known as the Pacific Coast Feeding Group that primarily feed in the Pacific Northwest. We examined 283 strandings from 44 years of data from 1977 to 2020 for Washington State. This region has seen relatively consistent responses to gray whale strandings over the period and provides an indication of gray whale mortality that is not as influenced by changes in response effort as other areas. Mortality in this region was documented in every year and month of the year but with some clear patterns. Most mortality occurs in spring months from April to June accounting for 71% of the strandings. While the long-term average strandings were 6.6/year for the whole period, elevated mortality occurred in several adjacent pairs of years including the large-scale 1999-2000 and 2019-2020 Unusual Mortality Events as well as 2005-06, consistent with a multi-year cause behind these elevations. These years were typically associated with increased observations of live whales in unusual areas off the typical
migration route or feeding areas of gray whales. While a wide variety of causes of death were documented, the most consistent finding during both average and elevated mortality years was emaciation in these animals, although determination of this can be confounded by post-mortem bloat and thick blubber layers that have very low lipid levels. Patterns in age class and geographic distribution were also noted. We examine how this unique long-term dataset provides key insights into the recovery of the ENP gray whale population, some of the threats they face as it potentially nears carrying capacity, and how gray whales try to adapt to these challenges.

Mercury and stable isotopes (δ13C and δ15N) assessment in pups of Galapagos sea lions (Zalophus wollebaeki) and Galapagos fur seals (Arctocephalus galapagoensis) of the Galapagos Marine Reserve

Paola Calle1, Juan José Alava2, Jorge Torres3, Omar Alvarado4, Maria Freire4, Ana Tirapé1, Gustavo Domínguez4, Diego Paez-Rosas5, Patricia Fair6, Omar Ruiz7
1Escuela Superior Politécnica del Litoral (ESPOL), Facultad de Ciencias de la Vida, Guayaquil, Ecuador, 2Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, British Columbia, 3Dirección Parque Nacional Galapagos, San Cristóbal, Galapagos, Ecuador, 4Escuela Superior Politécnica del Litoral, Guayaquil, Guayas, Ecuador, 5Universidad San Francisco de Quito, San Cristóbal, Galapagos, Ecuador, 6Medical University of South Carolina, Charleston, SC, 7Escuela Superior Politécnica del Litoral, Guayaquil, Guayas, Ecuador

Anthropogenic mercury is a pollutant of great concern and highly toxic to top predators, including marine mammals. Mercury can biomagnify in the foodweb and undergo long-range atmospheric transport from industrialized regions to remote locations of the global ocean like the Galapagos Islands. Galapagos sea lions (GSL, Zalophus wollebaeki), and Galapagos fur seal (GFS, Arctocephalus galapagoensis) are endemic and endangered marine mammals. These species serve as sentinels of ecosystem health to assess and monitor the exposure to and impact of pollutants in the Galapagos Marine Reserve (GMR). This research aimed to investigate total mercury (THg) bioaccumulation in both species of otariids and the trophic exposure relationship using natural stables isotopes (δ13C, δ15N). Hair samples were collected from pups (3 months of age) of GFS (n=50) and GSL (n=50) from seven rookeries of the GMR. The THg mean concentrations (±SD) in GFS were 15.53±4.9442 and 16.84±7.6677 mg/kg dried weight (dw) in males and females respectively; and 14.94±4.2665 and 15.68±9.6740 mg/kg (dw) in males and females of GSL, respectively. Inter-species and sex comparisons show no statistical significant differences between the two species (p>0.05). While no significant relationships (p>0.05) were found between THg and δ13C in both species and THg versus δ15N in GSL, a significant relationship (p=0.008) was observed between THg and δ15N in GFS, indicating that δ15N is an isotopic tracer to predict mercury accumulation in this species. The concentrations found in both species of are in average 3 times higher than those reported on California sea lion juveniles (Z. californianus) and similar than concentrations observed in Steller sea lion pups (Eumetopias jubatus). This study provides a first baseline on THg concentrations in Galapagos endemic pinnipeds, showing that these concentrations are higher than the human benchmark for mercury consumption of fish and highlighting that these species are contaminated by mercury.

Dietary plasticity of two coastal dolphins in the Benguela upwelling ecosystem

Michelle Caputo1, Simon Elwen2, Tess Gridley3, Sophie Kohler4, Jean-Paul Roux5, Pierre William
Defining trophic relationships within communities and the dietary preferences of marine predators is essential in understanding their role and importance in ecosystems. Here we use stable isotope analysis of skin samples ($\delta^{15}$N values reflecting trophic level and $\delta^{13}$C values reflecting foraging habitat) to investigate resource partitioning and spatial differences of the feeding ecology of dusky ($Lagenorhynchus obscurus$) and Heaviside’s ($Cephalorhynchus heavisidii$) dolphins from two coastal study sites separated by 400 kilometers along the coast of central (Walvis Bay) and southern (Lüderitz) Namibia in the Benguela upwelling ecosystem. Overall, isotopic niches of both predators were significantly different, indicating partitioning of resources and foraging habitats. Despite their smaller body size, Heaviside’s dolphins fed at a significantly higher trophic level than dusky dolphins. Stable isotope mixing models revealed that both species fed on high trophic level prey (i.e. large $Merluccius$ spp., large $Sufflogobius bibartus$, and $Trachurus t. capensis$) at Walvis Bay. The diet of both dolphin species included smaller pelagic fish and squid at Lüderitz. Spatial differences also highlight that Heaviside’s and dusky dolphins may exhibit dietary plasticity driven by prey availability, and that they likely form distinct population segments. Important prey for both dolphin species, specifically $Merluccius$ spp. and $T. t. capensis$, are the main target of trawl fisheries in the Benguela upwelling ecosystem, highlighting potential resource overlap between dolphins and fisheries.

**Geographically Distinct Blue Whale Song Variants in the Northeast Pacific**

**Alexander Carbaugh-Rutland$, Jeppe Have Rasmussen$, Blair Sterba-Boatwright$, Ana Sirovic$**

$University of Miami, Galveston, Texas, College of Science and Engineering, Texas A&M University – Corpus Christi, Corpus Christi, Texas, Texas A&M University Galveston, Galveston$

The Northeast Pacific (NEP) population of blue whales $Balaenoptera musculus$ is currently managed as a single stock. We investigated the fine-scale frequency characteristics of one NEP blue whale song unit, the B call. We analyzed B calls from passive acoustic data collected between 2010 and 2013 at two low latitude sites, Palmyra Atoll and the Hawaiian Islands, and three higher latitude sites, off Southern California, off Washington state, and in the Gulf of Alaska. Frequency measurements were extracted along the contour of the third harmonic from each call, and data from each region were compared. Calls from the Gulf of Alaska and Hawaii presented a downshift in frequency beginning just past the midway point of the contour, which was not present in those recorded from Southern California or Palmyra Atoll. Cluster analysis resulted in consistent grouping of call contours from Washington and Southern California, in what we termed NEP B1 variant, while contours from Hawaii and Gulf of Alaska were grouped together, as a NEP B2 variant. Frequency differences were also observed among the variants; the Gulf of Alaska displayed the highest frequency on average, followed by Washington, then Southern California.

Consistent with other studies, a yearly decline in the frequency of B calls was also observed. This discovery of at least two geographically distinct variants provides the first evidence of vocally distinct subpopulations within the NEP,
indicating the possibility of a need for finer-scale population segmentation.

**New Zealand marine top predators as target species to test two genetics-based ideas in evolutionary theory: The Abundant-Centre hypothesis and Seascape genetics**

Daniel Cárcamo¹, Mailliu Díaz², Jonathan Gardner³
¹Victoria University of Wellington, Wellington, New Zealand, ²Universidad de Valparaíso, Chile, ³Victoria University of Wellington, New Zealand

Genetic information is important to inform management and conservation. However, few studies have tested the relationship between genetic variation and latitudinal/environmental variation across marine species, and far fewer still for marine mammals. Here, we test two hypotheses with data from three marine mammals, the fur seal *Arctocephalus forsteri*, the sea lion *Phocarctos hookeri*, and Hector’s dolphin, *Cephalorhynchus hectori*. The Abundant-Centre Hypothesis (ACH) states that populations at the centre of a species’ distribution exhibit greater genetic variability than populations at the periphery (the ‘normal’ model). Variants of this model include the ‘ramped north’ (greatest variation in the north), the ‘ramped south’ (greatest variation in the south), and the ‘abundant edge’ (greatest variation at the distributional edges). The Seascape Genetics Test (SGT) null hypothesis predicts no association between genetic and environmental variation. We conducted a meta-analysis of published/unpublished material on marine mammal genetic diversity and marine environmental data. To assess the ACH, genetic data were fitted to four models (Normal, Ramped North, Ramped South, Abundant edge). We also conducted an analysis between the genetic outcomes of the ACH and abundance records. The SGT involved GLM analyses using eleven geospatial/environmental variables and species-specific genetic variation. The ACH results showed that 12 of 31 datasets (for all three species) fitted at least one model, with data from *Arctocephalus forsteri* and *Phocarctos hookeri* fitting the Ramped North and Normal models, respectively. Data for *Cephalorhynchus hectori* fitted the Abundant edge (mitochondrial DNA) and the Ramped North (nuclear DNA) models. Species-specific abundance records followed the same patterns detected by the ACH. For the seascape genetics analyses the species-specific $F_{ST}$ estimates (genetic distance between populations) were mostly affected by orbital wave velocity, solar radiation and sea surface temperature, suggesting that ocean currents and seawater temperature play a pivotal role in shaping genetic differentiation of populations of these species.

**Long-term social structure of coastal bottlenose dolphins in a highly urbanized subtropical lagoon in South Florida**

Jessica Carde¹, Jenny Litz², Thibaut Bouveroux¹, Amy Brossard³, Jesse Wicker¹, Joseph Contillo⁶, Jeremy Kiszka⁷
¹Florida International University, ²Marine Mammal and Turtle Division, SEFSC, NOAA Fisheries, Miami, Florida, ³University of South Alabama, Dauphin Island Sea Lab, Dauphin Island, AL, ⁴Cooperative Institute of Marine Atmospheric Studies, NOAA SEFSC MMTD Affiliate, Big Pine Key, FL, ⁵Cooperative Institute for Marine and Atmospheric Studies (CIMAS), NOAA Affiliate, Miami, FL, ⁶NOAA, SEFSC, Miami, FL, ⁷Florida International University, North Miami, Florida

Little is known about the long-term effects of environmental changes on coastal cetacean populations, particularly in tropical and subtropical ecosystems. This question is significant considering climate change and habitat destruction of coastal areas. Biscayne Bay (South Florida) is a hotspot for a wide range of human activities and has experienced dramatic seagrass declines over recent decades that have
reduced foraging habitats for coastal bottlenose dolphins (*Tursiops truncatus*). To examine possible effects of habitat degradation on association patterns, we investigated the social structure of bottlenose dolphins in Biscayne Bay using data collected over 30 years (1990-2020). Overall, 668 individuals were identified over 579 surveys and 1,564 sightings. The mean half-weight association index (HWI) for the population was 0.06±0.03 with a max HWI of 0.49±0.15. When analyzed by home range and sex, the highest HWIs were found among individuals who mainly reside in the southern, less impacted area of the bay and between males. For both sex and home range, mean HWI within-classes were significantly higher than between-classes. The population was well differentiated (S=0.867±0.023) and permutation tests for preferred/avoided associations showed that associations and avoidances were non-random. Temporal analysis revealed that associations do persist over time and that a mix of preferred companionship and casual acquaintance was the best fit model for the population (ΔQAIC=42.28), while two levels of casual acquaintance was best when analyzing sex-specific patterns of association (ΔQAIC=11.39). Overall, these results indicate that the social structure of bottlenose dolphins in Biscayne Bay could be significantly affected by urbanization and seagrass decline, where individuals using less degraded habitats exhibit the strongest associations. Future investigations will focus on assessing how the spatial differences in social structure might be influenced by habitat quality and affect foraging success, individual fitness, and survival rates of bottlenose dolphins in Biscayne Bay.

An Update on the Resident Population of Cuvier’s Beaked Whales (Ziphius cavirostris) of Guadalupe Island, México

**Gustavo Cárdenas Hinojosa¹**, Jennifer Trickey², Gregory Schorr³, Brenda Rone⁴, Erin Falcone⁵, Rodrigo Huerta⁶, Lorenza Rojas-Bracho⁷, Diana López-Arzate⁸, Erin Keene⁴, Andrea Bonilla-Garzón⁹

¹Comision Nacional de Areas Naturales Protegidas, Ensenada, Baja California, Mexico, ²Scripps Institution of Oceanography, San Diego, CA, ³Marine Ecology & Telemetry Research, Seabeck, Washington, ⁴Marine Ecology & Telemetry Research, Seabeck, WA, ⁵Marine Ecology and Telemetry Research, Seabeck, Washington, ⁶Centro de Investigación Científica y de Educación Superior de Ensenada, Ensenada, Baja California, Mexico, ⁷Ocean Wise, Ensenada, Baja California, Mexico, ⁸Proyecto de investigación zifido de Cuvier y otros cetáceos de Isla Guadalupe, Ensenada, Baja California, Ensenada, Baja California, Mexico, ⁹Sea Shepherd Conservation Society

Guadalupe Island (GI), a protected Biosphere Reserve with minimal human disturbance, represents a comparative study area to research Cuvier’s beaked whales (CBW) in a relatively pristine environment. We applied visual and passive acoustic methods to study seasonal, residency, movement, and habitat use patterns of CBW. Sixteen field trips to GI were undertaken from October 2016 to February 2021. During 1,150 hours of search effort, we recorded 384 sightings of CBW. Whales were mainly sighted within and between Bahía Norte and Campo Lima, in areas near submarine canyons. Group size ranged from 1 to 9 individuals, with a mean of 2.82 (SD = 1.58). Mother and calf pairs were sighted 93 times and were recorded during all field efforts. The photo-ID catalog from GI, started opportunistically in 2006, now contains 88 unique individuals, including sighting histories spanning more than 11 years and recaptures of 58 whales. These include several mom/calf re-sightings, critically important to understanding weaning and inter-calf interval in this species. A comparison of CBW photo-ID catalogs to date has resulted in no matches between the GI population and the Southern California population. Furthermore, a High-frequency Acoustic Recording Package (HARP)
was deployed within Bahía Norte from November 2018 to October 2020. CBW echolocation clicks were detected on all days of the 685-day acoustic monitoring period. CBW acoustic presence was much higher than the levels typically found at HARP sites in the Southern California Bight. Results from this study suggest year-round presence and a high degree of site fidelity indicating an island-associated resident population.

Trends in sympatric otariid populations suggest resource limitations in the Peruvian Humboldt Current System

Susana Cárdenas-Alayza1, Dimitri Gutiérrez1, Yann Tremblay2

1Universidad Peruana Cayetano Heredia, Lima, Lima, Peru, 2MARBEC, Sète, Herault, France

Sympatric species evolve mechanisms to avoid competition and coexist. In the productive upwelling Humboldt Current System, populations of South American sea lions (SASL, Otaria byronia) and South American fur seals (SAFS, Arctocephalus australis) fluctuate mostly due to El Niño Southern Oscillation (ENSO) events and prey availability. In this study, we evaluate population trajectories of Peruvian sympatric otariids and discuss mechanisms for competition and/or resource limitation. By using a combination of abundance time series, age-class proportions and biomass time series within and between species, we explore if larger body mass (SASL), a proxy for higher consumption of prey resources, can offer a greater competitive advantage in comparison to a smaller species (SAFS) to sustain population abundances in a common environmental setting. To achieve our goal, we analyzed population trajectories of SASL and SAFS in a sympatric breeding site in Punta San Juan, Peru between 2001-2019, after population recovery from the Extraordinary 1997-98 ENSO. Wavelet analysis was used to extract trends and derivatives to estimate rates and turning points. Age-class proportions and biomass times series were constructed from weekly counts. Both populations show a growth phase and subsequent decline. SAFS started decline ~2.25 years before and at a rate 1.5 times faster than SASL. Total pinniped biomass in PSJ has a range of 83.16 – 506.72 t with a mean of 335.26 ± 139.95 t reaching its maxima in March 2016. Throughout the time series 82.61 % ± 3.75 of total biomass is composed by SASLs, making this the ‘dominating’ species. We found that recent declines are driven by a reduction in the juvenile age-class in both species, suggesting that resource limitation is the main contributing factor. Meanwhile, the steeper decline in SAFS is possibly linked to the smaller proportion of adult female SAFS. Finally, trophic segregation studies are required to disentangle operational mechanisms behind coexistence.

Grey seal pupping in the Baltic

Anja Carlsson1, Markus Ahola2

1Swedish Museum of Natural History Department of Environmental Research and Monitoring, Uppsala, Sweden, 2Swedish Museum of Natural History, Stockholm, Sweden

Anja Carlsson, Markus Ahola Swedish Museum of Natural History

Grey seals (Halichoerus grypus) in the Baltic Sea have recovered from a population of only a few thousand in the 1970s to a population of around 60 000 today. They are unique among the pinnipeds in that they breed on free floating pack ice, land-fast ice and on land. However, the extent to which they breed on land along the Swedish coast is unknown. Identifying land breeding sites and ensuring that they continue to be available for grey seals and protected is therefore important. Here we present results from the first comprehensive aerial inventory of on land
pupping sites of grey seals. Compared with a smaller survey conducted in 2001 several new land pupping locations have been identified.

Ringed seal diet biomarkers identify spatial variation in carbon source use and trophic position across a latitudinal gradient of sea ice

Cody Carlyle¹, Jim Roth², David Yurkowski³, Brent Young⁴, Doreen Kohlbach⁵, Thomas Brown⁶, Steven Ferguson⁷
¹University of Manitoba/Fisheries and Oceans Canada, Winnipeg, MB, ²University of Manitoba, Winnipeg, Manitoba, ³Fisheries and Oceans Canada - Freshwater Institute, Winnipeg, MB, ⁴Fisheries and Oceans Canada, Winnipeg, MB, ⁵Norwegian Polar Institute, Tromso, Norway, ⁶Scottish Association for Marine Science, Oban, Argyll, United Kingdom, ⁷Fisheries and Oceans Canada, Winnipeg, Manitoba

The Arctic is undergoing climate driven changes to the extent, thickness, and phenology of sea ice. These changes are impacting sea-ice associated species such as ringed seals that consume sea-ice derived prey. Ringed seals experience vastly different icescapes across their broad latitudinal range, such as year-round coverage in the high Arctic to transient coverage in the low Arctic, and likely adjust their feeding to varying regional sea-ice conditions. We investigated how the foraging ecology of ringed seals varied with sea-ice conditions across a latitudinal gradient using concurrent analyses of diet biomarkers (highly branched isoprenoid (HBI) lipids for sea-ice derived carbon, δ¹³C for feeding environment, and δ¹⁵N for trophic dynamics) in ringed seal muscle (n = 115) and liver (n = 112) tissues from the low (Arviat, Nunavut: 61.1°N), intermediate (Pond Inlet, Nunavut: 72.7°N), and high (Grise Fjord, Nunavut: 76.4°N and Qaanaaq, Greenland: 77.5°N) Arctic in 2016-2018. From low to high latitude, we found a significant increase in δ¹³C from -21.1 ± 0.06‰ to -18.2 ± 0.15‰, decrease in relative carbon index from 1.05 ± 0.003 to 0.88 ± 0.01, increase in proportion of sea ice carbon from 22.0 ± 2.7% to 90.6 ± 1.9%, and increase in relative trophic position from 3.73 ± 0.02 to 4.65 ± 0.05. Our results indicate a greater reliance on sea-ice based and/or benthic prey at high latitudes likely driven by tighter sea ice-benthic coupling in this system, compared to a higher contribution of pelagic based carbon to ringed seal diets at low latitudes. Trophic position results indicate potential changes in zooplankton community complexity and/or piscivory in ringed seal diets between locations. Our results demonstrate considerable flexibility in the diet of a key Arctic species to regional sea-ice conditions, as well as how a high trophic level consumer can be an indicator of ecosystem function.

Regional and Ontogenetic Variation of Trace Element Ratios in Periotic Bone of West Indian Manatees

Ruth H. Carmichael¹, Kayla DaCosta²
¹Dauphin Island Sea Lab/ University of South Alabama, Dauphin Island, Alabama, ²Dauphin Island Sea Lab/University of South Alabama

Traditional methods for studying animal movement and habitat use are expensive and labor intensive. To provide an alternative method to reconstruct lifetime habitat use, we analyzed trace element (TE) ratios in growth-layer-groups (GLGs) of ear bones from West Indian manatees (Trichechus manatus). To define regional differences associated with migration, we compared data between animals in subregions of the northern Gulf of Mexico (nGOM; Mississippi, Alabama, Florida panhandle), which are areas of range expansion, and peninsular Florida (FL). We used laser ablation-inductively coupled plasma-mass spectrometry along transects perpendicular to GLGs to collect annuli-specific TE data for animals in each region. TE ratios in ear bones differed by region, with some elements distinguishing among nGOM subregions. Inverse salinity indicators, Ba and Sr, were higher and lower respectively in
nGOM subregions compared to FL, consistent with known regional differences in freshwater delivery. Ratios of most elements were higher in ear bones from Alabama manatees than all other subregions, but Cu increased westward, with highest values in FL. Age was a complex and significant predictor of elemental ratios in ear bones. Prior to age 5, Cu and Mn declined. After age 5, Sr declined while most other elements increased with age, and many elements showed approximately 5-year cycles of increasing and decreasing TE ratios. These patterns suggest TE ratios detect, and some variation may be imparted by, physiologically important life-history events such as weaning, sexual maturity and calving that happen on these timescales. As manatee populations recover and require additional resources, they are likely to continue expanding their range into outlying habitats. This dispersal is likely to increase with climate change, making TE ratios a useful tool to track regional and subregional-scale lifetime habitat use.

**Vessel traffic influences distribution of Aotearoa New Zealand's endemic dolphin (Cephalorhynchus hectori)**

William Carome¹, Steve Dawson², Liz Slooten², Will Rayment³, M. Hamish Bowman¹

¹University of Otago, Somerville, MA, ²Otago University, Dunedin, New Zealand, ³University of Otago, Dunedin, ⁴University of Otago

Cetacean tourism and vessel traffic have grown considerably around the world in recent decades. At Akaroa Harbour, Aotearoa New Zealand, recreational vessel traffic, dolphin tourism, and cruise ship presence increased substantially between 2008 and 2020. We examined the relationship between vessel traffic parameters and the presence of Hector's dolphins (*Cephalorhynchus hectori*) during the austral summer 2019 – 2020, using automated vessel tracking and autonomous passive acoustic monitoring. We collected data over 111 days, including the entirety of the first COVID-19 nationwide lockdown, during which vessel traffic was essentially nonexistent. Generalized additive models revealed that increasing levels of motor vessel traffic, the presence of cruise ships, and high levels of dolphin tour vessel traffic resulted in decreases in acoustic detections of dolphins. Our findings suggest that Hector's dolphins at Akaroa Harbour were displaced from core habitat in response to each of these vessel traffic parameters. We recommend that managers use immediately actionable tools to reduce the impacts of vessels on these dolphins.

**Fishing-Vessel-Strike Risk to North Atlantic Right Whales in the Gulf of St. Lawrence**

Meg Carr¹, Angelia Vanderlaan², Christopher Taggart³

¹Dalhousie University, Halifax, NS, ²Fisheries and Oceans Canada, Dartmouth, Nova Scotia, ³Department of Oceanography, Dalhousie University, Halifax, Nova Scotia

Vessel strikes are one of the leading identified sources of mortality for critically endangered North Atlantic right whales (*Eubalaena glacialis*; right whales). From 2017 to 2020, 32 right whales were observed dead in United States and Canadian waters. Of the 16 cases where cause of death was determined, 9 carcasses (56%) presented with injuries consistent with vessel strike, 7 of which (78%) were discovered in the Gulf of St. Lawrence (GSL). The GSL is an area with substantial shipping and fishing activities and lethal vessel-strike risk from large (>20 m) vessels that has been preliminarily quantified (same authors). However, no studies have investigated lethal vessel-strike risk derived from smaller fishing vessels in the GSL or elsewhere. The southwestern GSL is an area of particular concern as right whales have shifted their distribution to seasonally feed and socialize in this area and a considerable portion of the GSL snow crab fishing fleet transits through and actively fishes in this area. Right whales are not
only exposed to fishing gear entanglement risk but also lethal vessel strike risk as a recent study found that smaller vessels such as 15-meter long, 45 tonne Cape Islander lobstering vessels are capable of causing lethal injury to right whales (Kelley et. al 2021; Mar. Mam. Sci. 37(1), 251-267). Our research addresses the small-vessel risk knowledge gap by quantifying lethal vessel-strike risk to right whales based on the 2017 snow crab fishing fleet using mandatory Vessel Monitoring System (VMS) data in concert with visual right whale detections. Lethality is estimated for standard-dimension GSL snow crab vessels using the Kelley 4-layer model and associated whalestrike R package. Areas of concentrated risk that may be the focus of future management schemes are identified and risk under normal operating conditions is compared to risk during right-whale-triggered fishing area closures.

A chronology of calves: Documentation of growth rates and changes in body morphology in humpback whale (Megaptera novaeangliae) calves throughout their natal season on the Hawaiian breeding grounds.

Rachel Cartwright1, Amy Venema2, Vanessa Danielson3, Charlotte Dempster4, Dan Cesere2, Stacy Garlington2

1The Keiki Kohola Project, Delray Beach, FL, 2The Keiki Kohola Project, Kihei, Hawaii, 3The Keiki Kohola Project, 4Keiki Kohola Project, Kihei, HI

The waters around the Hawaiian islands comprise the primary breeding grounds for North Pacific humpback whales. This breeding stock, designated the Hawaii Distinct Population Segment, accounts for around 60% of the North Pacific humpback whale population. Maternal females likely give birth near or within inter-island waters, and then persist in the area to raise their calves. Here, we present a compilation of aerial and underwater imagery documenting calf growth and development through this critical period. Beginning with images of neonate calves captured moments after birth, we provide new details on growth rates and accompanying maturation of calves over the course of the natal season. Anecdotally, we describe new instances of aggressive behavior in escorts and protective maternal behavior around the youngest neonates. Additionally, we provide details of variability in the dynamics of growth and maturation in recent seasons that may provide new insights into recent fluctuations in reproductive rates and calf survivorship for this population segment.

Occurrence of pinnipeds in the Beach Monitoring Project from Saquarema (Rio de Janeiro) to Laguna (Santa Catarina) - Brazil from 2015 to 2020.

Claudia Carvalho do Nascimento1, Cristiane Kiyomi Miyaji Kolesnikovas2, Henrique Chupil1, CLAUDIO Souza Vieira Junior1, Marina Zabini4, Carlos Belruss4, Alexandre Marinielli6

1Mineral Engenharia e Meio Ambiente, Brazil, 2Associação R3 Animal, Florianópolis, Brazil, 3Instituto de Pesquisas Cananéia, Cananéia, São Paulo, Brazil, 4Mineral Engenharia e Meio Ambiente, São Paulo, São Paulo, Brazil

The Santos Basin Beach Monitoring Project (PMP-BS) is an activity developed to meet the federal environmental licensing of Petrobras' oil and natural gas production and flow activities in the Santos Basin, carried out from Laguna (Santa Catarina) to Saquarema (Rio de Janeiro) in Brazil. From 2015 to 2020, 6,244 marine mammals were recorded, among them, 910 were pinnipeds (14.57%). During this period, six species were recorded: *Arctocephalus australis* (70.66%), *Arctocephalus gazella* (0.11%), *Arctocephalus tropicalis* (13.52%), *Lobodon carcinophaga* (0.55%), *Mirounga leonina* (1.98%) and *Otaria flavescens* (4.51%) and unidentified (8.68%). Data collection started on 08/24/2015 and represented 4.51% of the total of mammals in the year, 7.59% (2016), 5.28% (2017), 40.59% (2018), 18.04% (2019) and
23.98% (2020). A total of 451 dead animals and 458 live animals were recorded. Of the live animals, 57.47% remained on the beach, 6.58% were translocated or released, and 25.57% were treated on the beach and 10.38% were sent to rehabilitation centers. Two individuals *Arctocephalus tropicalis* were rehabilitated (one in Florianópolis - Santa Catarina and the other in Cananéia- São Paulo) and after clinical and laboratorial exams, were released back to the wild. The individual released in Cananéia- São Paulo was recaptured after five days and immediately released in Florianópolis-Santa Catarina (distance 300 kilometers). These were the first releases after captive rehabilitation of this sub-Antarctic species by PMP-BS. This work demonstrates the importance of longitudinal monitoring to establish the knowledge of the occurrence of pinnipeds species in the region of Saquarema-RJ to Laguna -SC- Brazil.

**Environmental Contaminants of New Zealand’s Endangered Endemic Hector’s Dolphin (Cephalorhynchus hectori)**

*Deborah Casano-Bally*¹, *Katharina J. Peters*², *Karen Stockin*³

¹Massey University, Auckland, New Zealand, ²University of Zurich, Adelaide, Australia

Due to their coastal distribution, Hector’s (*Cephalorhynchus hectori hectori*) and subspecies Māui (*Cephalorhynchus hectori maui*) dolphins are exposed to land run off and point source inputs. However, little focus has been placed upon contaminant burdens, despite infectious disease increasing within the species over the past decade. Several persistent environmental pollutants are known immunosuppressants, enhancing disease susceptibility. We examined temporal trends in concentrations of PCBs and multi-residue pesticides in the blubber of 65 (31 males and 34 females) stranded and by-caught Hector’s and Māui dolphins between 1997 and 2021. $\sum$DDT ranged from 44 to 57,390 (Mean = 12,419, S.D = 16,507) and 93.7 to 12,860 (Mean 2,444, S.D = 3,126) and µg/kg lipid weight in males and females, respectively. In females, mean $\sum$DDT increased from 1,358 (S.D = 1,974) to 3,597 (S.D = 3,733) µg/kg lipid weight between 1997-2009 and 2010-2021, respectively. Males recorded less change between the same period, with mean $\sum$DDT 12,389 (S.D = 18,161) compared to 12,445 (S.D = 15,582) µg/kg lipid weight recorded, respectively. $\sum$PCB concentration ranged from 16.2 to 5,574 (Mean = 1,425, S.D = 1,307) and 45.5 to 1,875 (Mean = 439, S.D = 450.3) and µg/kg lipid weight in males and females, respectively. $\sum$ICES7CBs in males ranged from 45.9 to 4,276 (Mean = 1,386, S.D = 1,268) and 14.9 to 2,593 (Mean = 988.3, S.D = 741.9) µg/kg lipid weight between 1997-2009 and 2010-2021, respectively. In females, $\sum$ICES7CBs increased significantly from 28.9 to 742.7 (Mean = 236.3, S.D = 200.1) to 70.5 to 10,746 (Mean = 1,285, S.D = 2,606) µg/kg lipid weight between the same sampling periods, respectively. Examination of these findings in the context of pathobiology is required for those individuals whose contaminant burdens exceed levels known to induce biological effect.
Occasional death and consequent stranding of cetaceans is part of their life cycle, however in the current case of *Eschrichtius robustus* (Gray Whale) recently increased mortality there has been established an unusual mortality event (UME). 215 whales stranded along the North Pacific Coast of North America in 2019, which caught the attention of the U.S. National Oceanic and Atmospheric Administration to declare a Gray Whale UME (NOAA 2020). Several institutions deployed their teams along the Canadian, USA and Mexican Pacific coasts to gather relevant information about the status of this species. *E. robustus*’ reproductive cycle takes part in the Pacific Coast of Baja California, Mexico. San Ignacio Lagoon and Ojo de Liebre Lagoon are two of the favorite areas for Gray Whales to gather in mexican waters, and it is there where a team from Laguna San Ignacio Ecosystem Science Program (LSIESP) and Marine Mammal Investigation Program (PRIMMA) from Universidad de Baja California Sur (UABCS) examined carcasses of stranded individuals of *Eschrichtius robustus*. Date, geographical location, sex, age, morphometrics, nutritional status, Smithsonian score, scavenging, human interaction signs, blubber characteristics and, if possible due to decomposition status, anatomopathological findings were recorded. In this study we will specifically describe the macroscopic changes found in the anatomy of two stranded dead animals, a juvenile and a calf, whose carcases were examined anatomopathologically given their Smithsonian score of 3 and 2, respectively, were we found significant multiorganic fat depletion, malnutrition signs, possible findings related to oil spill, cardiac abnormalities, and a post mortem human interaction. These post-mortem findings could unveil information from both individuals and population, explaining possible ethiology of death on each individual and an initial correlation between the increase in mortality and nutritional status of the *E. robustus* population.

The secret lives of humpback whales in El Salvador: Creating the first national photo-identification catalog for their conservation

Melvin Castaneda¹, Nicola Ransome², Ted Cheeseman³, Paula Cabanilles⁴

¹Fundación Naturaleza El Salvador, Acajutla, Sonsonate, El Salvador, ²Murdoch University, ³HAPPYWHALE, ⁴Proyecto Megaptera El Salvador

The study of many aspects of cetacean ecology is made possible by the ability to identify individuals in space and time. Humpback whales (*Megaptera novaeangliae*) can be easily identified by photographing the unique shape and pattern of the ventral part of their flukes. Despite the presence of a population of endangered humpback whales being in El Salvador each winter, extensive research has been extremely limited in this Central American country. Prior to 2018, only fluke identification images of eleven individual whales existed. In recent years, the conservation initiative of Proyecto Megaptera El Salvador has increased photo-identification efforts, primarily in the Los Cóbanos Complex Marine Protected Area and Ramsar Site. This is an area of great economic and ecosystemic importance for Salvadorans and of economic interest for foreign investment projects because it is very close to the country's main seaport. In recent years, humpback whale watching tourism has generated the interest of the government, the media, artisanal fishermen and researchers, so it
is important to discuss how our findings on these individual whales are a contribution to the country's economy, science and for the rights of the local communities and of this vulnerable species that has historically been threatened and on which many other species and ecosystems depend. This effort highlights the identification of 122 whales unique to El Salvador, which allows the construction of the first photo-identification catalog of humpback whales in El Salvador to collaborate with their conservation.

Census of the Juan Fernandez fur seal (Arctocephalus philippii) using unmanned Aerial Vehicles (UAVs): Preliminary results on the assessment of animal disturbance and limitations when using different UAVs models

Victor Castillo1, Renato Borras-Chavez2, MICHAEL E GOEBEL3, Carla Rivera4, José Miguel Fariña5, Valentina Vergara-Caro5, Luciano Hiriart6
1NGO Costa Humboldt, Valdivia, Chile, 2Center of Applied Ecology and Sustainability-CAPES, Pontificia Universidad Catolica de Chile, Punta Arenas, Chile, 3University of California Santa Cruz, La Jolla, CA, 4Center of Applied Ecology and Sustainability-CAPES, Pontificia Universidad Católica de Chile, Santiago, Chile, 5NGO Costa Humboldt, Puerto Montt, Chile, 6NGO Costa Humboldt, Chile

The Juan Fernandez fur seal is the least known fur seal species in the world. Endemic to the Juan Fernandez archipelago, the distances between islands, the geographic complexity and the reactivity of animals makes data collection challenging. We present a comparative assessment of animal disturbance using three different UAVs (Mavic pro (M), Phantom 4 (P4) and Phantom 4 pro V2 (P4V2). We tested animal response behavior in both reproductive (R) and non-reproductive (NR) aggregations when no wind was present. We defined three behavioral categories: No response (NR, which means animals do not move from initial position), Vigilance (VIG, animals only lift their heads), and Locomotion (LOC, animals standing and moving). STP was never triggered for R aggregations out of concern for pups. Initial state of the animals was REST for all testing sessions. Data collection began at UAV altitude of 50 meters (m) and recorded every 5 m until STP was observed (NR aggregations only), or LOC (for R aggregations). VIG was triggered at 25 m for both R and NR aggregations using UAVs M and P4V2. In contrast, VIG behavior was triggered at 35 m using the P4. STP did not occur until 10 m altitude for NR aggregations using M or P4V2 and at 15 m when P4 was used. In R aggregations LOC was induced between 11-20 m despite the model. Sudden acceleration had the effect of behavioral changes at higher altitudes. We recommend altitudes 25 - 35 m for any UAV activity to avoid disturbance when operating over both NR and R aggregations. Finally, although P4 may not be the best alternative considering noise and animal disturbance, GPS connection stability, independence from phone apps for mapping, and other technical differences made it the UAV of choice in remote, isolated areas.

Common Dolphin (Delphinus delphis) Fission-fusion Dynamics on the South Coast of Portugal

Joana Castro1, Claudia Faustino1, André Cid2, Alicia Quirin1, Rui Rosa1, Heidi Pearson4
1AIMM - Marine Environment Research Association, Lisboa, Portugal, 2AIMM, Lisboa, Portugal, 3School of Biological Sciences - University of Aberdeen, AIMM - Marine Environment Research Association, Ferreiras, Portugal, 4MARE, Lisboa, Portugal, 5University of Alaska Southeast, Juneau, Alaska

Animals whose social structure is characterised by a high degree of fission-fusion dynamics live in fluid societies where party (group) size varies widely on a temporal scale. In these societies, the joining (fusion) and separation (fission) of parties is considered a trade-off between the associated
costs and benefits of grouping. This study investigates potential factors influencing fission-fusion dynamics in common dolphins (*Delphinus delphis*) off the South coast of Portugal, a region that is an important nursery and feeding ground for the species. Between May and October of 2016 and 2017, 96 boat-based group focal follows (using a 2-min sampling interval) were conducted, resulting in 2450 samples. We used logistic Generalised Linear Models (GLM) and Generalised Estimating Equations (GEE) to examine if the presence of mother-calf pairs, behavioural state (foraging, resting, socialising, travelling) and time (time of day, month, year) influence party size (1 to 75, median = 11 animals). Furthermore, we used GEE multinomial logistic regression to test if the presence of mother-calf pairs, party size and time influence behavioural state and group size change (fission/ fusion/ stable). Our results suggest that party size is strongly influenced by the presence of mother-calf pairs ($p < 0.001$) in addition to behavioural state ($p < 0.05$) and time ($p < 0.05$). Common dolphin party size is significantly smaller when there are no mother-calf pairs present, and when animals are resting or travelling vs. foraging or socialising. Additionally, party size decreases throughout the day with indications that groups disperse at midday. Analysis is still ongoing but there are indications that groups are more stable when travelling and when mother-calf pairs are present. By assessing the fine-scale dynamics of grouping in common dolphins, this study represents an important step towards understanding the costs and benefits of group formation in wild cetaceans.

Aerial Sonogram: Pairing Endocrine Markers with Morphometrics to Detect Reproductive State in Humpback Whales (*Megaptera novaeangliae*)

Kelly Cates¹, Shannon Atkinson DeMaster², Martin van Aswegen³, Andrew Szabo⁴, Jan Straley⁵, Lars Bejder⁶, Christine Gabriele⁷, Janet Neilson⁷

¹University of Alaska Fairbanks, Douglas, AK, ²University of Alaska Fairbanks, ³Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Honolulu, Hawaii, ⁴Alaska Whale Foundation, Petersburg, Alaska, ⁵University of Alaska, Sitka, Alaska, United States Minor Outlying Islands, ⁶Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, Hawaii, HI, ⁷Glacier Bay National Park, Gustavus, AK

Unprecedented marine climatic events are increasingly affecting the North Pacific. These events may be particularly problematic for recovering populations where large scale regional surveys occur infrequently. These types of surveys are critical for understanding basic population trends, such as reproductive rates. Tools that reduce the cost and time needed to inform on reproductive rates would be beneficial to the understanding of the species in question and shed light on the health of the ecosystem as a whole. Determining pregnancy status in live baleen whales is challenging, with the most accurate assessments of pregnancy deduced from hormones obtained from blubber or feces, or retrospectively after a female is documented with a calf. Here we demonstrate the potential for complementing existing techniques for assessing pregnancy in humpback whales (*Megaptera novaeangliae*) by incorporating Unoccupied Aerial Systems (UAS; drones) and additional hormones of interest. Enzyme immunoassays were validated for progesterone, cortisol, aldosterone and DHEAS use in blubber biopsy samples for 41 female humpback whales, including three calves, from Southeast Alaska in 2019. A pregnancy threshold of 12.34ng/g was established, with a pregnancy rate of 55% calculated for this population of whales based on blubber progesterone concentrations. Aerial images were obtained for the same 41 biopsied whales and basic morphometrics were analyzed
relative to reproductive status. The area of the body that best predicted pregnancy was the region 45-60% along the length axis from the rostrum. Additionally, while influential in modeling, no clear trend was observed in relation to pregnancy for cortisol, aldosterone or DHEAS. Determining pregnancy in humpback whales by using UAS is a promising method. With continued development and the use of complementary data such as sighting histories for age, confirmation of pregnancy and hormonal indicators of pregnancy, UAS technology has the potential for the rapid, non-invasive assessment of pregnancy.

**Surfing for Survival**

*Jorge Cazenave¹, Juan Copello¹, Ingrid Visser²*

¹Punta Norte Orca Research, Chubut, Argentina, ²Orca Research Trust, Tutukaka, New Zealand

*New Zealand*

Orca (*Orcinus orca*) surf in the shore-breaks of New Zealand and Peninsula Valdés, Argentina. We investigated the occurrence and function of surfing events and how they may be linked to foraging techniques. The species is known worldwide for its highly adaptive methods of foraging, some of which can be high-risk (e.g., barbs from stingrays) and habitat orientated (e.g., hunting close to shore poses inherent hazards such as stranding). The New Zealand Coastal orca hunt for various species of rays, sometimes in extremely shallow (< 3m) waters, where the risk of stranding is increased. For Punta Norte orca who hunt along the coast of Península Valdés, their strategy of intentionally stranding to take young sealions (*Otaria flavescens*), likewise increases the risk of stranding. Records were collated from photographic and videographic data collected during longitudinal studies of both populations. The resulting dataset extended over more than a decade for each population and showed that both sexes and all age classes surf in both locations. We documented youngsters accompanying adults during surfing sessions, perhaps as teaching scenarios, which then manifest as a cultural tradition in each of these two populations. Orca surfing behaviour does not appear to be influenced by the state of the tide, however it is impacted by weather conditions.

We suggest that skills obtained during surfing, such as familiarity with waves and aptitude to manoeuvre in surf, may reduce the chances of stranding by potentially providing the orca with techniques for recovery and extraction from surf zones. In addition, if stranded, an understanding of near-shore wave dynamics may assist with a successful retreat from the danger zone. Such a repertoire of skills would likely increase the long-term chances of survival for individuals and this may also reflect why these orca begin learning the technique at a young age.

**Quantitative comparison of visual and acoustic surveys for the detection and dynamic management of North Atlantic right whales (Eubalaena glacialis) in Canada**

*Valentina Ceballos¹, Hansen Johnson², Christopher Taggart³*

¹Dalhousie University, Halifax, NS, ²Dalhousie University, ³Department of Oceanography, Dalhousie University, Halifax, Nova Scotia

Near real-time acoustic detections of North Atlantic right whale (hereafter “right whale”) calls are currently used interchangeably with visual observations to trigger risk-mitigation measures in Canadian waters. Comparing these two survey methods is critical for correct survey data interpretation and development of optimal monitoring strategies. The goals of this study were to develop a simulation-based method to quantitatively compare acoustic and visual surveys, and to use the simulation to inform future right whale management. We expanded upon an established whale movement model by adding calling and diving behaviors based on
previous observations. We then applied this model to generate distributions of surfacings and calls for whales constrained within dynamic management zones established by Fisheries and Oceans Canada and Transport Canada in the Gulf of Saint Lawrence. We simulated the detection of these whales by acoustic surveys from ocean gliders and visual surveys from planes and vessels on a per transit basis using realistic platform movements and detection functions. A Monte Carlo approach was used to estimate the probability of detecting a single call or surfacing from each platform as a function of the number of whales in a zone, transits performed, and management zone. Results suggest that there are substantial differences between acoustic and visual survey performance, as the glider always detected right whales, while visual surveys required multiple transits and large numbers of whales to reliably detect whale presence. Our results provide a tool that can be used by decision-makers to inform optimal right whale monitoring strategies that consider the relative strengths of each survey platform.

**Whiskers of leopard seals provide a time-series of contaminants, trace elements, and stable isotope ratios**

Patrick Charapata¹, Casey Clark², Nathan Miller³, Sarah Kienle⁴, Daniel Costa⁵, Emily Sperou¹, Heather Gunn¹, Mike Goebel⁶, Shane Kanatous⁷, Daniel Crocker⁸, Renato Borras-Chavez⁹, Stephen Trumble¹⁰

¹Baylor University, ²University of Washington, Fairbanks, ³University of Texas at Austin, Austin, Texas, ⁴Baylor University, McGregor, TX, ⁵Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, ⁶NOAA - Fisheries, ⁷Colorado State University, ⁸Sonoma State University, Rohnert Park, CA, ⁹Center of Applied Ecology and Sustainability-CAPES, Pontificia Universidad Catolica de Chile, Punta Arenas, Chile, ¹⁰Baylor University, Waco, Texas

Efficient tools for tracking contaminants are needed to monitor the health of Antarctic flora and fauna in an era of rapid environmental changes and increasing human presence. Leopard seals (Hydrurga leptonyx) are important apex predators that consume diverse prey in the Antarctic Peninsula and have a top-down effect on several Antarctic pinnipeds and seabirds. Leopard seals likely serve as a sentinel species that can be used to track and monitor contaminant changes, such as total mercury, a neurotoxin, in the Antarctic Peninsula ecosystem. Leopard seal whiskers grow continuously for ~1 year and incorporate trace elements and ecological biomarkers as they grow, thereby recording a time-series of ecophysiological data from the past year. However, leopard seals are poorly studied and little data has been reported on contaminant loads in this species. Our objective was to examine the ability of leopard seal whiskers to serve as a matrix for acquiring time-series data of important ecological biomarkers, including contaminants (total mercury and lead), trace elements (selenium and zinc), and stable isotope values. We analyzed leopard seal whiskers (n = 19) collected during 2018 – 2019 for total mercury, lead, selenium, and zinc concentrations and obtained longitudinal profiles of each element. Our contaminant results show that total mercury varies widely along whiskers (mean ± SD, range, 3.77 ± 1.66, 0.023 - 12.77 ppm); this indicates that total mercury concentrations are dynamic and change by over an order of magnitude during fine-scale whisker growth. These results provide the first crucial time-series data on contaminant loads in leopard seals and may infer the health of the Antarctic ecosystem. Further, we predict that our analyses of trace elements and stable isotopes will indicate similar fine-scale changes in foraging location, trophic level, and trace element profiles, making leopard seal whiskers a viable biomonitoring tool of trace elements over
Mapping Medium-Sized Arctic Cetaceans from Space
Bertrand Charry¹, Emily Charry Tissier², John Iacozza³, Marianne Marcoux⁴, Cortney Watt⁴
¹Whale Seeker, Inc., Montréal, Québec, ²Whale Seeker, Inc., Montréal, Québec, ³University of Manitoba, Winnipeg, Manitoba, ⁴Fisheries and Oceans Canada, Winnipeg, Manitoba

Wildlife monitoring is an important aspect of wildlife conservation and management to determine the viability and prosperity of a population. Emergence of new technologies in remote sensing gives scientists a new way to detect and monitor wildlife populations. To date, aerial surveys – using human observers and aerial photography – is the most common method for obtaining spatial and demographic information to estimate population abundance. However, aerial surveys require significant manpower, preparation, and financial resources; therefore, they are done once every few years to monitor cetacean populations. In this study we assess the ability to detect and classify two emblematic Arctic cetaceans, the narwhal (Monodon monoceros) and beluga whale (Delphinapterus leucas). As harvested species for subsistence by Inuit communities these species require frequent monitoring to assess population trends and ensure sustainable management. We analyzed 12 very high resolution (VHR) satellite images acquired in August 2017 and 2019, collected by the WorldView-3 satellite, which has a maximum resolution of 0.31 m per pixel. The images covered Clearwater Fiord (138.8 km²), an area on eastern Baffin Island, Canada where a portion of the endangered beluga Cumberland Sound population spend a large part of the summer, and Tremblay Sound (127.0 km²), a narrow water body located on the north shore of Baffin Island that is used by narwhals during the open water season. We successfully detected a total of 292 beluga whales and 109 narwhals. This study contributes to our understanding of Arctic cetacean distribution and highlights the capabilities of using satellite imagery to detect marine mammals.

A Happy Collaboration: Basin-scale, High-throughput, AI-assisted Photo-ID Matching for North Pacific Humpback Whales
Ted Cheeseman¹, Katherina Audley², Astrid Frisch³, Nicola Ransome⁴, Jorge Urban⁵, Pamela Martinez Loustalot⁶, Jeff Jacobsen⁷, Ester Quintana-Rizzo⁸, Joëlle De Weerd⁹, Daniel M. Palacios¹⁰, Craig Hayslip¹¹, John Calambokidis¹², Kiirsten Flynn¹³, Phil Clapham¹⁴, Christie McMillan¹⁵, Jackie Hildering¹⁶, Janie Wray¹⁷, Nicole Doe¹⁸, Caitlin Birdsell¹⁹, Karina Dracott¹⁹, James D. Darling²⁰, Josie K. Byington²¹, Tasli Shaw²², Mark Mallison²², John K.B. Ford²³, Thomas Doniol-Valcroze²⁴, Janet Neilson²⁵, Jan Staley²⁶, Suzie Teerlink²⁷, Jen Cedarleaf²⁸, Andrew Szabo²⁹, Fred Sharpe³⁰, John Moran³¹, Heidi Pearson³², Olga von Ziegesar³³, Briana Witteveen³⁴, Denny Zwiefelhofer³⁴, Craig Matkin³⁵, Rachel Cartwright³⁶, Stephanie Stack³⁷, Jens Currie³⁷, Meagan Jones³⁷, Edward Lyman³⁸, Rachel Finn³⁹, Christine Gabriere⁴⁰, Adam Pack⁴¹, Beth Goodwin⁴¹, Kym Yano⁴², Lars Bejder⁴³, Martin van Aswegen⁴⁴, Marie Hill⁴⁵, Jo Marie Acebes⁴⁶, Olga Filatova⁴⁷, Olga Titova⁴⁸, Evgeny Mamaev⁴⁹, Greg Donovan⁵⁰, Jeff Moore⁵¹, Jay Barlow⁵², Marilia Olio⁵³, Hayley Newell⁵⁴, Ken Southerland⁵⁵
¹Southern Cross University, ²Whales of Guerrero, Portland, OR, ³Ecologia y Conservacion de Ballenas, ECOBAC, Puerto Vallarta, Jalisco, Mexico, ⁴Murdoch University, ⁵University Autonoma de Baja California Sur, La Paz, BCS, Mexico, ⁶Universidad Autonoma de Baja California Sur, La Paz, Mexico, ⁷VE Enterprises, McKinleyville, California, ⁸Simmons University, ⁹Association ELI-S, Gujan-Mestras, France, ¹⁰Oregon State University, Newport, Oregon, ¹¹Oregon State University, Newport, OR, ¹²Cascadia Research Collective, Olympia, ¹³Cascadia Research Collective, Olympia, Washington, ¹⁴Seastar Scientific, Vashon, Washington
We present a North Pacific-wide humpback whale (*Megaptera novaeangliae*) photo-ID dataset capturing over 60% of the living population. Humpback whale photo-ID using natural features of the ventral fluke has enabled individual recognition-based studies since the 1960s. Photo-ID was the primary methodology for the groundbreaking SPLASH study, 2004-2006, establishing migratory patterns and population parameters. Since SPLASH, however, no North Pacific basin-wide effort has been maintained despite the obvious need for such data (due to rapidly changing humpback populations and an apparent increased frequency of oceanographic events such as marine heat waves). We utilized AI-assisted photo-ID to overcome the impediment of time-intensive manual image matching to build a dataset of 26,125 individually identified humpback whales in over 120,000 encounters. The data was contributed by a collaboration of 42 research organizations and from more than 4000 citizen science contributors. The data are managed within a bespoke web-based information architecture accessible at Happywhale.com. The immediate impact of this rich, ocean basin-wide high capture probability dataset is a shift from data scarcity to data abundance for a wide-ranging migratory species. For example, as of March 2021, we have found 276 breeding ground interchanges between Hawaii and Mexico, about 3% of each area’s population, where previous to this collaboration only about 20 such interchanges had been found, about 0.25% of previously compared dataset populations. The long term nature of this dataset has opened new views of change in breeding ground-feeding...
ground associations over the lifetime of individuals, and reveals patterns of in- and out-migration between population segments. In high sample-effort sub-regions such as Southeast Alaska, capture probabilities above 90% are enabling studies that would be otherwise inconceivable, such as assessing changes in body condition between breeding and feeding grounds. This dataset is contributing to new population-specific estimates of abundance and survival.

**Passive Acoustic Monitoring of Large Whales on and off the Continental Shelf of Southern California using Autonomous Underwater Vehicles**

Kristen Ampela¹, Jessica Chen², Selene Fregosi², David Mellinger⁴

¹HDR, Inc., San Diego, California, ²NAVFAC Pacific, Kaneohe, Hawaii, ³Cooperative Institute for Marine Resources Studies, NOAA Pacific Marine Environmental Laboratory and Oregon State University, Hatfield Marine Science Center, ⁴Cooperative Institute for Marine Resources Studies, NOAA Pacific Marine Environmental Laboratory and Oregon State University, Hatfield Marine Science Center, Newport, OR

A passive acoustic monitoring survey using autonomous gliders was conducted in winter 2020 in the Southern California Bight, in order to characterize the temporal and spatial distribution of cetaceans in the region, particularly in relation to U.S. Navy training and testing areas. Two gliders were flown to cover 1) the abyssal plain offshore of the continental shelf break (‘abyssal glider’), and 2) inshore of the shelf break in water depths shallower than 2500 m (‘shelf glider’). The abyssal glider surveyed 940 km over 50 days and recorded 763 hours of acoustic data. The shelf glider malfunctioned after only five days and was recovered after surveying just 95 km and recording 87 hours of acoustic data. Acoustic data were analyzed for vocalizations of several large whale species using a suite of species-specific automated detectors. Blue (*Balaenoptera musculus*), fin (*B. physalus*), humpback (*Megaptera novaeangliae*), and sperm (*Physeter macrocephalus*) whale vocalizations were recorded by the abyssal glider, and fin and humpback vocalizations by the shelf glider. The abyssal glider recorded blue whale B calls on three separate days, all while the glider was inshore of the shelf break. Fin and humpback vocalizations were particularly abundant; fin whales were detected on every day of both glider deployments, and humpback whales were detected on 53 of 55 survey days, both on and off the continental shelf. The abyssal glider recorded sperm whales on 12 of 50 recording days, when the glider was surveying over the shelf break and the abyssal plain. The deep-water areas on the shelf slope and the abyssal plain are seldom surveyed for marine mammals, making these results particularly valuable for understanding marine mammal occurrence and distribution in these areas.

**Genetic relationship within stranding events in pygmy killer whales**

Yu-Rong Chen¹, Hurng Yi Wang², Hao-Ven Wang², Chih-Wei Chang³, Jack Wei-Cheng Yang⁵

¹Institute of Ecology and Evolutionary Biology, National Taiwan University, Taipei, Taiwan, ²Graduate Institute of Clinical Medicine, National Taiwan University, Taipei, Taiwan, ³Department of Life Sciences, National Cheng Kung University, Tainan, Taiwan, ⁴Marine Ecology and Conservation Research Center, National Academy of Marine Research, Kaohsiung, Taiwan, ⁵Conservation Medicine Lab, Dept. Vet Med, NTU, Taipei, Taiwan

Social structure is a consequence of many evolutionary forces and might further influence the conservation genetics. In blackfish, many species are known to form social groups with close relatives such as killer whales and short-finned pilot whales. Pygmy killer whales
(PKW) (*Feresa attenuata*), around Hawaii waters, are also reported to form stable social groups while the kinship within groups is never studied. We hypothesized that PKWs form social groups with closely related individuals which is similar to what is known in other studied blackfish. DNA samples were collected from 39 PKWs from 13 stranding events (8 of them are mass stranding events) around Taiwan waters during 2010-2020. We calculated the pairwise relatedness using high-resolution restriction-associated DNA (ddRADseq) and SPAGeDi software. In five mass stranding events (5/8, 62.5%), all or part of individuals from the same event are closely related (Loiselle's kinship coefficient \( k >0.0075 \)) and more than one male relatives are noted in one of the events. However, individuals from the same event were not closely related in other three mass stranding events (3/8, 37.5%). These findings indicate that individuals in same social group of PKWs are not necessarily closely-related. The possible explanations include a high dispersal rate and the heterogeneity of social groups in PKWs. This is the first study of the genetic relationship within stranding events in PKWs in West Pacific which gives insight into the social nature of this cryptic species.

**Spy in the sky: a novel method to identify pregnant small cetaceans**

**Barbara Cheney¹, Julian Dale², Paul M. Thompson¹, Nicola Quick³**

¹University of Aberdeen, Cromarty, United Kingdom, ²Duke University Marine Lab, ³Duke University, Marine Lab, Beaufort, NC

Reproductive failure can be a key constraint in population growth. Reproductive success is therefore an important metric for accurately estimating demographic rates, yet data can be difficult to collect in wild cetacean populations. Long-term individual-based studies provide a unique opportunity to apply unmanned aerial system (UAS) photogrammetry to non-invasively measure body morphometrics of individuals with known life history information. The aims of this study were 1) to ground-truth length measurements from UAS photogrammetry with laser photogrammetry and 2) to explore whether UAS measurements of body width could be used to remotely determine pregnancy status in a well-studied population of bottlenose dolphins in the Moray Firth, Scotland. We carried out five boat-based surveys in July and August 2017, with concurrent photo-identification, UAS and laser photogrammetry. Photographs were measured using bespoke programmes, MorphMetriX for UAS photos and a Zooniverse project for laser photos. In total 64 dolphins were identified using photo-ID, 47 of which had concurrent UAS and laser body length measurements. We also measured body widths at 10% increments from 10-90% of body length for six females subsequently known to be pregnant, nine known to not be pregnant and four of unknown pregnancy status. There was no significant difference in the length of individuals measured with UAS and laser photogrammetry. Discriminant analyses of the body width-length ratios expected to change during pregnancy (20-60%), correctly assigned pregnancy status for 14 of the 15 females of known pregnancy status. Only one pregnant female was incorrectly assigned as non-pregnant. The four reproductive females of unknown pregnancy status were all assigned with a not pregnant status. Our study validates that UAS and laser photogrammetry measurements are comparable in small cetaceans and is the first to demonstrate that UAS measurements of body width-length ratio can accurately assign pregnancy status in bottlenose dolphins.

**Eyes in the Sky: 3D Scanning a Dead Humpback Whale with UAS Photogrammetry and Lidar**

**Ellen Chenoweth¹, Josh Houston², Jan Straley³**

¹University of Alaska Fairbanks, ²Jfactory, Sitka,
Stranded large whales represent an unpredictable and infrequent opportunity to learn about the anatomy and condition of free-ranging animals. A remote location, weather, tides, personnel and time often limit access to a carcass. On March 14th, 2021, a dead female adult humpback whale was reported stranded on an uninhabited island 15 miles west of Sitka, Alaska. A UAS (Uncrewed Aerial System) (DJI Mavic 2 Pro) was used to scan the whale in 3D using photogrammetry to create a georeferenced 3D surface with detailed texturing of the whale’s flanks and ventral surface. Four days later, the whale was scanned again in a new orientation that exposed its dorsal surface during a necropsy to determine cause of death. The whale was 13.4 m long and in a state of moderate decomposition. The whale was scanned using photogrammetry immediately before, after the necropsy (NOAA Fisheries permit 18786-01) and 17 days later. Individual features (blubber, parasites, exposed organs and body cavities) were 3D scanned using using Polycam (https://poly.cam/) on an iPad Pro 2020, which uses a combination of Lidar and images to generate a textured mesh in the field. The result is an interactive, geospatially referenced 3D interface hosted on the website sketchfab.com. While it is becoming common for museums to 3D scan their display items, including a few extant and fossilized whale skeletons, we are unaware of another 3D scan involving a large whale with soft tissue for teaching, research and public display. Three-dimensional imaging provides post-hoc examination and measurement of soft tissue by specialists unable to travel to the animal in real time, to determine cause of death or for other research applications. Annotations reviewed by a necropsy specialist will result in a dense and engaging virtual experience for students and the public.

It is well established that the social environment can influence an individual’s behaviour and reproductive fitness. Social network analysis is an increasingly applied tool for quantifying an individual’s social interactions and characterising a group’s dynamics as a whole. To date, many social network studies have been constructed using physical proximity (e.g., nearest neighbour) or interaction data (e.g., grooming). Acoustic signalling interactions, however, have frequently been overlooked in social network analyses, even though such signals are intrinsic features of many social groups. Here, we use vocal network analysis to shed new light on social network complexity in Indo-Pacific bottlenose dolphins (Tursiops aduncus). The dolphin population in Shark Bay, Western Australia, exhibits a fission-fusion grouping pattern in an open social network. Here, males form decades-long, multi-level alliances, in which individuals engage in coordinated efforts to compete with rivals over access to single oestrous females. Proximity-based association networks of these alliances have been studied extensively over the past 35 years but, their vocal networks have not been characterised. In this study, we construct weighted and directional vocal networks of five core alliances (35 males) using signature whistle exchanges. Signature whistles were identified using acoustic localization and SIGID, and exchanges were defined as events in which two signature whistle
types occurred within three seconds of each other. We compare the vocal networks to the proximity-based association networks using MRQAP to test for dependence. We show that while undirected proximity-based networks reflect differentiated dyadic bond strengths, the directed vocal networks characterize emergent properties of group, such as information flow and group connectedness. Our work reveals novel insights into the social complexity of bottlenose dolphins through vocal network analysis and demonstrates the applicability and importance of integrating acoustic networks into social network studies.

Can the Licado system be the most effective repellent to mitigate depredation induced by Bottlenose dolphins on Tunisian purse-seines?

Mourad Cherif¹, Rimel Benmessaoud², Arwa Chakroun³, Wael Kouched⁴

¹Institut National des Sciences et technologies de la Mer, Tunis, Tunisia, ²INAT/INSTM, Tunis, Tunisia, ³INAT, Tunis, Tunisia, ⁴Institut National des Sciences et technologies de la Me, Tunis, Tunisia

Depredation is defined as the damage or removal of fish or bait from fishing gear by predators. Depredation induces opportunity costs associated with the damage to fishing gear, the time spent in mending depredated, the cost of purchase of new gear, the time required to move to another fishing area in order to avoid possible depredation events, the fuel costs associated with this relocation and the expense of additional fishing effort to compensate for lost catches. The purpose of our study was to test a new acoustic device "Licado system" with a new interactive triggering function. During November 2020 to July 2021, two « Licado system » were tested on two vessels targeting small pelagics fishes. A combination of questionnaires and participatory experiments were used to assess depredation rate, mending costs and catch per unit effort of the sampled vessels.

The deterrents tested showed a depredation rate (% depredation\textsubscript{Licado} = null; % depredation\textsubscript{control} = 29.76) and associated mending costs (mending costs\textsubscript{Licado} = 290 body\_nbs; mending costs\textsubscript{control} = 417$) dropped notably with a net increase in the catch per unit effort compared to control purse-seiners (CPUE\textsubscript{Licado} = 13 749 Tons; CPUE\textsubscript{control} = 9 039 Tons). The efficiency of this type of device remains above 90% even after nine months of trial. However, the experimentation should be continued in order to specify the period of adaptation.

**Key words:** Bottlenose dolphin, depredation, purse-seine, Licado system, efficiency, Tunisia.

Thinking before eating - Southern elephant seals detect and select prey well before striking

Mathilde Chevallay¹, Pauline Goulet², Peter Teglberg Madsen³, Julieta Campagna⁴, Claudio Campagna⁵, Christophe Guinet⁶, Mark Johnson⁶

¹Centre d’Etudes Biologiques de Chize, Neuvecelle, France, ²Sea Mammal Research Unit, University of St Andrews, St Andrews, Fife, United Kingdom, ³Aarhus university, ⁴Puerto Madryn, Chubut, Argentina, ⁵Centre d’Etudes Biologiques de Chizé (CEBC), Chize, France, ⁶University of St Andrews, St Andrews, Fife, United Kingdom

Predators that can detect prey at a distance, such as echolocating toothed whales, are able to hunt deliberatively by selecting both targets and approach tactics well before prey respond. This capability may be critical for efficient foraging in large time-limited divers that forage on relatively small prey. However, deep-diving seals such as Southern elephant seals (SES) appear to have little sensory advantage over their prey. Both SES and their prey rely on visual and hydrodynamic cues that may be detectable only at short ranges in the deep ocean, suggesting that SES must adopt a less efficient reactive mode of
hunting. To investigate how SES detect and approach their prey, we deployed integrated sonar and movement tags on 22 post-breeding female SES to record simultaneously predator and prey behaviour during foraging interactions. The tags recorded some 250,000 potential prey patch encounters in 1052 days as judged from acceleration transients. Assuming that SES would alter their direction of travel when detecting a prey patch, we measured changes in pointing angle as a function of time prior to prey strikes. We show that SES detect their prey 4-10 s before striking, at a distance of 4-17 m. In comparison, prey responded to SES approach at distances of 0.8 ± 0.5 m. Some SES also adopted prey-dependant hunting tactics, consistently performing a stereotyped backflip manoeuvre when targeting schooling prey. This tactic likely serves to aggregate the school and may enable multi-prey loading. Our results demonstrate that SES have a sensory advantage over their prey allowing them to identify and select prey, and to decide on capture tactics before prey react. The ability of SES to deliberatively control foraging interactions until within striking distance of prey may be a key factor in the success of this far-ranging generalist predator.

Ahab facing north: the relevance of the northern area of the MPA- Mediterranean Cetacean Migration Corridor for the sperm whale.

Carla A. Chicote¹, Manel Gazo², Natalia Amigó³, Jose Antonio Vazquez⁴, Nuria Andon⁵, Ana Cañadas⁶
¹SUBMON® –m, Barcelona, Barcelona, Spain, ²SUBMON & University of Barcelona, ³SUBMON, BARCELONA, BARCELONA, Spain, ⁴ALNILAM, Sabiñanigo, Huesca, Spain, ⁵Alnilam Research and Conservation, Navacerrada, Madrid, Spain

The Mediterranean Cetacean Migration Corridor is an off-shore MPA that extends over 46,000 km² along the Spanish Levantine coast upgraded in 2020 as a SAC (Special Area of Conservation). In summer 2020, an acoustic and visual survey was conducted to identify the relevance of the northern area of this MPA for deep-diving cetacean species. Specific objectives of the study were a) to confirm the areas as a feeding area for sperm whales, b) to establish the connectivity between sperm whale populations with other relevant areas, such as Gulf of Lions, Ligurian Sea, Northern Balearic Islands and Straits of Gibraltar. A total of 680 km on acoustic and visual effort were navigated over the two main underwater canyons (1622 km²). Sightings confirmed the presence of the four deep-divers species in the Mediterranean: sperm whale, Cuvier’s beaked whale, long-finned pilot whale and Risso’s dolphin. A total of 109 acoustic detections and 71 sightings were made. Data collected allowed to obtain an estimated total abundance of 21.41 sperm whales (CV=35.77%; IC (95%) = 12.02 /38.55) with a density of 0.007162 ind./km². 11 sperm whales were individually photo-identified. Comparison of SUBMON catalogue with other research groups resulted in individuals from our study are resighted in the Gulf of Lion and north off Balearic Islands. Resighted individuals differed from only few days to over ten years supporting the importance of the area for the movements of sperm whale males in this part of the Mediterranean. High values of density and presence not only of males, but groups of females with calves and juveniles highlight this MPA as a special importance area for this species both for feeding and breeding. To prioritize and apply management measures for the preservation of the species within this Corridor must be in the agenda of this MPA managers.

Not all are equal: Humpback whales (Megaptera novaeangliae) from Iceland display preferences towards certain breeding grounds.

Valerie Chosson¹, Charla Basran², Frederick Wenzel³, Lindsey Jones⁴, Laurent Bouveret⁵,
¹SUBMON® –m, Barcelona, Barcelona, Spain, ²SUBMON & University of Barcelona, ³SUBMON, BARCELONA, BARCELONA, Spain, ⁴ALNILAM, Sabiñanigo, Huesca, Spain, ⁵Alnilam Research and Conservation, Navacerrada, Madrid, Spain
Photographic identification of individual humpback whales across the North Atlantic has enabled researchers to document long distance migrations from the feeding grounds (mid- and high latitudes) and the breeding grounds (low latitudes). Iceland is a discrete feeding ground in the eastern North Atlantic. The Ísland Megaptera Novaeangliae (ISMN) Catalogue contains 1,380 unique individuals identified in Icelandic waters since 1982. Previous research demonstrated that humpback whales from this feeding ground migrate to all the known breeding grounds in the North Atlantic but appear to exhibit site preferences, and their breeding range includes sites thought to be used by the Endangered Cape Verde breeding population.

In this study, 634 individuals were compared to the North Atlantic Humpback Whale Catalogue (NAHWC), which includes individuals from across the North Atlantic based on 44 years of dedicated surveys and opportunistic encounters. In total, there are 95 individuals from Icelandic waters that were recaptured in one of the North Atlantic breeding grounds. Most were documented on breeding sites in the western Caribbean, which are used preferentially by populations no longer thought to be at risk of extinction. However, since 2015, the number of documented migrants between the Icelandic feeding grounds and the understudied Lesser Antilles breeding ground increased from 6 to 19 individuals, while the number of recorded matches to the endangered population of the Cape Verde breeding ground increased from 6 to 16. These results confirm the continued presence of humpback whales from Iceland feeding grounds on breeding areas along both the eastern and western margins of the Atlantic. However, continued research in Iceland, along with the breeding grounds, has the potential to improve understanding of North Atlantic stock structure and a population of management concern in the eastern North Atlantic.

Two-decade-long sighting and stranding records reveal fine-scale distribution and group composition for Fraser’s dolphins (Lagenodelphis hosei) off Taiwan

Ching-Wen Chou¹, Hsin-yi Yu¹, Lien-Siang Chou¹, Ing Chen¹
¹National Taiwan Normal University, Taipei, Taiwan, ²Institute of Ecology and Evolutionary Biology, National Taiwan University, Taipei, Taiwan

Scientific knowledge on species’ distribution or range is vital for conservation management, particularly for those frequently being involved in human-wildlife conflicts. Fraser’s dolphin (Lagenodelphis hosei) is one of the less studied
dolphin species in the world, yet one of the most common victims in fisheries in the tropics. The species has been known to occur in Taiwanese waters since the species was rediscovered in the 70s, and reportedly being negatively-affected by local fisheries. However, their distribution and movement patterns, as well as their group structure, is still largely unknown; and the lack of science-based knowledge impedes the implement of meaningful conservation management. Here, we analyzed 25 years (1995—2020) of sighting and stranding records of Fraser’s dolphins in Taiwanese waters. We used Geographic Information System (GIS) to analyze the data and visualize the distribution of this species around Taiwan in a fine scale. We also examined whether the occurrence pattern, for both shipboard observations and stranding reports, could be attributed to environmental factors such as coastal geometry, nearshore water-depth, or sea surface temperature. Our results showed that Fraser’s dolphins appear to be present in Taiwanese waters year-round, and occur mainly in the eastern coasts of Taiwan. Most of the sightings were concentrated nearshore (ca. 7 km to the coast) where the water is 200—2000 m deep. The dolphins were mostly found when the surface water temperature was ca. 28 °C. No mass stranding event had ever been reported, but at sea the dolphins were seen traveling with their conspecifics at all times, and the group size ranged from dozens to thousands. The groups with mother and calf pairs tend to be larger than without. Our findings by-and-large agree with the findings reported in earlier studies for the populations in the Eastern Tropic Pacific, the Philippines, and the Azores.

**International policy, recommendations, actions and mitigation efforts of anthropogenic underwater noise**

Emily Chou¹, Brandon Southall², Martin Robards¹, Howard Rosenbaum³


Anthropogenic underwater noise levels have generally increased as industrial activities in the ocean have become more prevalent. Because of the central nature of sound in the lives of many marine animals, and the known and potential adverse impacts of noise, it is also gaining increased international recognition as an important global conservation issue. Here, a current compilation and synthesis of official documents, reports, and strategic plans from various intergovernmental, governmental, and international organizations, and noise-related projects and programs, demonstrate increasing efforts to understand anthropogenic underwater noise, and the mitigation and management measures that are being considered to reduce noise. While some entities aim to better understand and quantify underwater noise and its impacts, others have recommended explicit mitigation measures including spatio-temporal approaches to managing noise sources, and vessel quieting technologies. New approaches also include the development of certification or voluntary noise-reduction programs and agreements. We highlight four considerations that will better link the potential impacts of noise with corresponding mitigation and noise reducing efforts: 1) collaboration to address the transboundary and cumulative nature of underwater noise; 2) differing countries’ implementation capabilities for addressing noise; 3) time and intensity tradeoffs (e.g., louder noise for a shorter time period versus quieter but for longer); and 4) variable noise impacts depending on specific life history stages and life functions. Our review affirms the international consensus that anthropogenic underwater noise is a currently pervasive yet relatively transient form of pollution, the effects of which can be significantly reduced through effective mitigation and regulatory action.
Using bioenergetic models to investigate the winners and losers of the offshore disturbance on marine mammals

Magda Chudzinska¹, John Harwood², Katarina Klementisova³, Cormac Booth⁴
¹University of St Andrews, St Andrews, United Kingdom, ²St Andrews, United Kingdom, ³University of St Andrews, St Andrews, Fife, United Kingdom, ⁴SMRU consulting, St Andrews, United Kingdom

Disturbance can cause behavioural, physiological and health changes that subsequently affect an individual’s vital rate, and eventually population dynamics. Bioenergetic models, such as Dynamic Energy Budgets (DEB), have been used to infer how an individual’s energy stores and allocation change with behavioural state or as a consequence of disturbance. Understanding when and how disturbance impacts individuals and populations remains critical for effective management and conservation efforts. We will present a set of DEB models for three marine mammal species: harbour porpoises, harbour and grey seals and demonstrate how they were used to assess the effect of different levels of disturbance connected to construction of wind farm (corresponding to a 1-24h cessation of foraging on a day of disturbance) and residency pattern, obtained from spatially explicit movement models, on vital rates (conceptions, births, survival). We focused on the effect of different levels of disturbance connected to construction of wind farm (corresponding to a 1-24h cessation of foraging on a day of disturbance) and residency pattern, obtained from spatially explicit movement models, on vital rates (conceptions, births, survival). We found that effects were strongest for more resident species; widely ranging species were less affected by the same level of disturbance. The effect was also affected by the time animals had to recover in between disturbance events: more spread disturbance days, even if over a longer period, had lower effect that disturbance concentrated over a shorter period. We also identified key sensitive periods that differ by species and were correlated with conception and pupping/calving season.

The models required values for more than 30 parameters each and taking account of the uncertainties that are associated with these values is critical. We will demonstrate how Approximate Bayesian Computation (ABC) can be used to quantify the uncertainty associated with parameters that are not directly observable.

Visual health assessment of the resident community of Indo-Pacific humpback dolphins (Sousa chinensis) in Hong Kong waters during the COVID-19 pandemic

Tabris Yik To Chung¹, Brian Chin Wing Kot², Henry Chun Lok Tsui³, Shuk Yee Kwan⁴, Heysen Hei Nam Ho⁵, Maria Jose Robles Malagamba⁶
¹City University of Hong Kong, Hong Kong, ²City University of Hong Kong, Hong Kong, China, ³City University of Hong Kong, Hong Kong S.A.R., China, ⁴City University of Hong Kong, ⁵City University of Hong Kong & Royal Veterinary College, Tseung Kwan O, Hong Kong, ⁶City University of Hong Kong, Hong Kong, Hong Kong

Indo-Pacific humpback dolphins (Sousa chinensis) are endangered resident cetaceans in Hong Kong waters. Under the “One Ocean One Health” paradigm, these top predators with long lifespans are good sentinels for ecosystem and human health. Current evaluation on their biological health relies on opportunistic study on stranded cases, which bodies are often badly decomposed and may not reflect the population health. It is crucial to include live animals in the scope of study. For free-ranging cetaceans in Hong Kong waters, visual health assessments by vessel-based photography and aerial videography were conducted biweekly since 2020, the commencement of the COVID-19 pandemic. Individuals were photo-identified by the contour of dorsal fins to compile a catalogue of the local community. Resighted individuals were longitudinally assessed on their biological health visually. Different health concerns, for example
deformed fins, skin infections by diatom and fungus, and skeletal conditions like lordosis, were observed. Results were compared with previous report [1] on the prevalence of epidermal lesions (220/435, 50.6% in previous study; 70/263, 26.6% in this study) and injuries/traumas (45/435, 10.3% in previous study; 17/263, 6.5% in this study) on the local humpback dolphin community before the COVID-19 pandemic to understand variation and temporal changes of dolphin health, and a reduction in both was observed. Ectoparasites sharksucker and barnacles were also recorded [2]. In addition, habitual foraging pattern around fishing boats and an incident of epimeletic behaviour [3] were documented using drone. Together with on-going postmortem investigation, our findings bridged the biological health assessment on both live and deceased cetaceans in Hong Kong waters. The results may facilitate related government officials and stakeholders to formulate and implement effective management plans for disease and injury prevention for the endangered dolphins.

Acknowledgements
This research was funded by Southern Marine Science and Engineering Guangdong Laboratory (Guangzhou) (SMSEGL20SC02) and CityU Strategic Research Grant (CityU 11104721).

The Impact of Ecology on Proportional Orbit Size in Whales
Morgan Churchill1, Colin Baltz2
1University of Wisconsin Oshkosh, Laramie, Wyoming, 2University of Wisconsin Oshkosh, Oshkosh, WI

Orbit length, a reliable proxy for eye diameter in mammals, varies within whales. To determine how differences in life history and ecology may influence eye size, we measured orbit length and bizygomatic width for 70 extant and 29 fossil whale taxa, calculating a proportional orbit ratio for each species. We then used GLM linear regression to test for correlations of orbit size with body size and diving ability. We also used permutation ANOVAS to examine whether orbit size was significantly different between taxa inhabiting different habitats (freshwater, nearshore, and offshore) and using different prey capture strategies (skim, engulfment, suction, ram, snap, and grip-and-tear feeders). We found that total body length and mass was the best predictor of orbit size, with proportional orbit size decreasing as body size increases. Taxa that seem to violate this trend include Mesoplodon, Platanista, Lipotes, and Balaenidae. A much weaker relationship existed for diving depth and duration, with an increase in dive depth and duration being associated with an increase in orbit size, which may explain the pattern in Mesoplodon. Significant differences in orbit size exist between different habitats and prey capture strategies. Freshwater species such as Platanista and Lipotes, had significantly smaller orbit ratios than nearshore and offshore taxa, and suggest decreased utility of eyesight in sediment-laden rivers. Ram and suction feeding whales had the largest orbit ratios, while skim-feeding whales had some of the smallest orbit ratios, suggesting a reduced need for vision with this method of prey capture. Overall, allometry explains most variation in proportional orbit size, but ecological adaptations cause some species to deviate from this pattern.

Circadian Clockwork and Mitochondrial Metabolism in a Diving Mammal: is Hypoxia Tolerance linked to Time of the Day?
Chiara Ciccone1, Fayiri Kante1, David Hazlerigg2, Lars Folkow3, Alexander West1, Shona Wood2
1UiT - The Arctic University of Norway, Norway, 2UiT - The Arctic University of Norway, 3University of Tromso, The Arctic University of Norway, Tromso, Norway

Deep diving mammals have evolved physiological and biochemical adaptations, that
enable them to cope with limited availability of oxygen (hypoxia). Among pinnipeds, the hooded seal (Cystophora cristata) has remarkable diving capacities, being able to dive repeatedly to ~1 km depth and to stay submerged for almost 1 hr. Previous studies have revealed physiological, biochemical and molecular mechanisms that provide high tolerance to prolonged and repeated hypoxia in this species. At the molecular level, the exposure to hypoxia typically leads to the expression of hypoxia-inducible factor 1 (HIF-1) which, among other things, mediates the switch from aerobic oxidative phosphorylation in the mitochondria to the less efficient ATP-producing process of anaerobic glycolysis in many tissues. Hooded seals display diurnal variations in both diving rate, depth and duration, performing longer and deeper dives during the morning/day than during the evening/night. This implies that there are certain times of the day during which they are more likely to experience severe hypoxia, which, again, may cause rhythmic induction of HIF-1. Recent evidence, from non-diving mammals, show that the responses to hypoxia are both tissue-specific and time-of-the-day dependent. Indeed, several studies suggest that the HIF-1 signalling pathway is actively interacting with the molecular clock. One possible outcome of this interaction is circadian regulation of mitochondrial metabolism. Using primary skin fibroblasts cultures derived from hooded seals we characterized the pinniped molecular clock and validated the presence of a circadian oscillation in the expression of core clock genes. By measuring the oxygen consumption rate in permeabilized and synchronized skin fibroblasts, we further show that there is a diurnal variation also in mitochondria activity. Based on these preliminary results, we hypothesize that by interacting with HIF-1 to regulate mitochondrial activity, the clock apparatus may influence tissue protection, metabolic regulation and hypoxia tolerance mechanisms in pinnipeds.

Site fidelity of bottlenose dolphins in Alabama waters using elemental analyses

Lauren Clance¹, Thibaut Bouveroux², Carl Cloyed³, Carrie Sinclair⁴, Kevin Barry⁴, Keith Mullin⁵, Ruth H. Carmichael⁶

¹University of South Alabama, Dauphin Island Sea Lab, Mobile, Alabama, ²University of South Alabama, Dauphin Island Sea Lab, Dauphin Island, AL, ³Dauphin Island Sea Lab, Dauphin Island, AL, ⁴NOAA, Pascagoula, MS, ⁵NOAA Fisheries Southeast Fisheries Science Center, Pascagoula, MS, ⁶Dauphin Island Sea Lab/University of South Alabama, Dauphin Island, Alabama

Little is known about community structure and habitat use of bottlenose dolphins (Tursiops truncatus) in the northcentral Gulf of Mexico, an area highly impacted by freshwater inputs and anthropogenic influences such as industry, shipping, and oil spills. To begin to fill these data gaps, we characterized seasonal patterns of site fidelity of dolphins in Mobile Bay, Alabama and nearby waters of the Gulf of Mexico. The major objective of this study was to determine if dolphins exhibit site fidelity to different subareas of the study area, and if so, does this site fidelity drive differences in diet and contaminant exposure. To distinguish habitat-specific seasonal exposure to conditions such as freshwater and contaminants, I analyzed elemental ratios (stable isotope, SI; trace element, TE) in dolphin skin to determine if individuals or groups of dolphins use specific habitat areas during summer (Jun-Aug) and winter (Dec-Feb). Skin samples were collected by remote biopsy darting from individual bottlenose dolphins, distinctly identified by photo-identification during biopsy surveys. SI ratios (carbon, nitrogen) were determined by isotope ratio mass spectrometry, and TE ratios (As, Ba, Cd, Co, Cr, Cu, Fe, Pb, Sr) were determined by laser ablation inductively coupled plasma mass spectrometry. Photo-identification during capture-mark-recapture surveys corroborated site fidelity by individuals and
groups of dolphins detected by elemental analyses. To link site fidelity to diet, SI ratios in dolphin skin were compared to ratios in muscle of prey species collected in the same season and location as dolphin samples. Preliminary results indicate SI ratios are geographically distinct along a salinity gradient in the bay, demonstrating potential for these trends to be reflected in SI ratios of resident dolphins. Our findings will inform spatio-temporal and population level scales for population management and conservation strategies of this and other delphinid populations in bay, sound, and estuarine habitats worldwide.

**Remote monitoring of cetacean mass strandings via Very High Resolution satellites: Challenges and opportunities**

**Penny Clarke¹**, Hannah Cubaynes², Karen Stockin³, Carlos Olavarria⁴, Asha de Vos⁵, Peter Fretwell⁶, Jennifer Jackson⁷  
¹British Antarctic Survey/University of Edinburgh, United Kingdom, ²British Antarctic Survey, ³Massey University, Auckland, New Zealand, ⁴CEAZA, Coquimbo, Coquimbo, Chile, ⁵Oceanswell, Crawley, ⁶British Antarctic Survey, Cambridge, Cambridgeshire, United Kingdom, ⁷British Antarctic Survey, Cambridge

The study of cetacean strandings was recognised globally as a priority topic at the 2019 World Marine Mammal Conference, in recognition of its importance for understanding the threats to extant cetacean communities and, more broadly, the threats to ecosystem and human health. Rising multifaceted anthropogenic and environmental threats across the globe is likely to coincide with an increase in reported strandings. Very High Resolution (VHR) satellite imagery offers the prospect of upscaling monitoring of mass strandings in unpopulated and inaccessible areas, over broader spatial and temporal scales not possible with traditional monitoring methods, and can be used to retrospectively analyse historical stranding events. Here we (1) compile global strandings information to identify the current data gaps; (2) discuss the opportunities and challenges of using VHR satellite imagery to monitor strandings using the case study of the largest known baleen whale mass stranding event and; (3) consider where satellites hold the greatest potential for monitoring strandings remotely. To utilise this platform to monitor mass strandings over global scales, considerable technical, practical and environmental challenges need to be addressed and there needs to be greater inclusivity in opportunity, through knowledge sharing and equality of access to imagery.

**The importance of oceanographic fronts as foraging habitats for diving odontocetes over daily to seasonal scales**

**Tommy Clay¹**, Gemma Carroll⁷, Megan Cimino⁴, Anthony Lyons⁴, Bruce Martin⁴, Jennifer Miksis-Olsw⁴, Peter Miller⁷, Timothy Moore⁷, Joe Warren⁴, Elliott L. Hazen⁷  
¹University of California, Santa Cruz, ²Southwest Fisheries Science Center, Environmental Research Division, National Oceanic and Atmospheric Administration (NOAA), Monterey, California, ³Institute for Marine Sciences, University of California Santa Cruz, SANTA CRUZ, California, ⁴Center for Coastal and Ocean Mapping, University of New Hampshire, Durham, New Hampshire, ⁵JASCO Applied Sciences, Dartmouth, NS, ⁶Center for Acoustics Research and Education, University of New Hampshire, Durham, New Hampshire, ⁷Remote Sensing Group, Plymouth Marine Laboratory, Plymouth, Devon, United Kingdom, ⁸Harbor Branch Oceanographic Institute, Florida Atlantic University, Fort Pierce, Florida, ⁹Acoustic Laboratory for Ecological Studies, School of Marine and Atmospheric Sciences, Stony Brook University, Southampton, NY, ¹⁰Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, Monterey, CA

Oceanographic fronts are known to be important
foraging habitats for a wide range of marine taxa. Sea surface temperature (SST) fronts are thought to aggregate lower trophic-level organisms, making them accessible to air-breathing predators. Yet, the mechanisms by which they influence prey distribution throughout the water column and hence, the foraging activity of deep-diving species, remain poorly understood. Here, we combined continuous acoustic detections of cetaceans at seven sites, with satellite-derived front maps, to investigate the bio-physical drivers of cetacean habitat use along the continental slope of the north-western Atlantic Ocean. We focused on four groups of odontocetes spanning a range of dive depths - unspecified delphinids (shallow-to-moderate divers), pilot whales Globicephala spp. (moderate-to-deep), beaked whales Ziphiidae and sperm whales Physeter macrocephalus (deep divers) – in order to test the hypothesis that species which feed in surface to mesopelagic waters would respond more to variation in surface oceanography than deep-divers. We modelled daily detections across a three-year period and found consistently higher cetacean activity at sites along the northern edge of the Gulf Stream (Virginia, Cape Hatteras) and during winter, driven by lower SSTs and stronger and more persistent fronts. Variation in detections over daily-weekly scales was explained by front proximity, with higher cetacean activity on days with nearby (<10 km away) fronts. As predicted, frontal metrics influenced foraging activity to the greatest degree for dolphins, to a lesser extent for pilot and beaked whales, with a negligible effect for sperm whales. As such, our results indicate that diving cetaceans associate with dynamic fronts over a range of spatiotemporal scales, but that this effect diminishes with depth. Our findings highlight the need for more detailed studies integrating subsurface oceanography with measures of vertical prey density-distribution, to examine the specific roles of fronts as aggregating features for predators foraging at depth.

**Vocal Behavior of Foraging Gray Whales Tagged with Bio-Logging Devices Determined Using an Accelerometer-Based Caller Identification Method**

**Hannah Clayton**, John Calambokidis, David Cade, Rianna Burnham

*Stanford University, Cascadia Research Collective, Olympia, Fisheries and Oceans Canada, Victoria, British Columbia*

Acoustic monitoring of baleen whale individuals and populations, via remote recorders or animal-borne biologging devices, has become more widespread over the past decade as the relationship between temporal and geospatial trends in calling behavior and population dynamics have been explored. Gray whales, like most baleen whale species, are thought to produce sound for a variety of social and behavioral functions. However, these are currently not well-understood, as most studies of this species have been conducted on breeding grounds and during migration, and not feeding grounds. To address questions concerning the acoustic behavior of Eastern North Pacific gray whales on foraging grounds, we analyzed data from 12 multi-sensor, animal-borne tags deployed from 2015-2021 on foraging gray whales in northern Puget Sound, Washington. We utilized both acoustic and accelerometer tag components, where it was possible, to differentiate between calls produced by the tagged whale and those produced by whales nearby. Findings from this comparison were then applied to tags that did not carry a hydrophone to identify potential calls in accelerometer data alone. Of 181 acoustically detected calls, 24 were concluded to be produced by tagged animals based on simultaneous hydrophone and accelerometer detection. An additional 28 calls were detected for tags that did not have an acoustic component. Vocalizations in our data displayed similarities to call types previously described. Most frequent were moan-like calls, which were primarily produced while the caller was not actively engaged in foraging behavior.
Our results demonstrate 1) the relevance of this accelerometer-based method in caller identification of a more vocally complex whale species, 2) significant intra- and inter-deployment variation \( (p < 0.05) \) in call kinematics such as speed and depth and, 3) variation in location and group-specific acoustic behavior such as call type use, and calling rates and patterns compared to currently available research.

**Targeted Surveillance Detected Novel Beaked Whale Circovirus (BWCV) in Ten New Host Cetacean Species Across the Pacific Basin**

Cody Clifton\(^{1}\), Ilse Silva-Krott\(^{2}\), Kristi West\(^{3}\)

\(^{1}\)University of Hawai‘i at Mānoa, Kailua, HI, \(^{2}\)Annandale, Virginia, \(^{3}\)University of Hawaii, Kaneohe Bay, HI

The first cetacean circovirus, beaked whale circovirus (BWCV), was recently reported in a Longman’s beaked whale (*Indopacetus pacificus*) stranded in Hawai‘i and represents an emergent disease with unknown population impacts. In other species, circovirus infection may cause mortality or opportunistic coinfection by other pathogens. We report on a targeted surveillance of stranded cetaceans in the Pacific basin where pathological findings suggested disease presence. Archived tissues from the brain, kidney, liver, lung, spleen, and lymph nodes of individuals stranded between 1997 and 2021 \((n=31)\) were tested by PCR for the presence of BWCV. Suspect positive tissue amplicons were confirmed as BWCV through sequencing. Of the screened individuals, 16 animals tested positive in one or more tissues, with a single striped dolphin (*Stenella coeruleoalba*) testing positive in all six tissues. The highest rate of detection among positive cases was found in the brain \((71\%)\), followed by the lungs \((67\%)\) and lymph nodes \((67\%)\). These results expand the potential host range for BWCV into ten additional odontocete species. New host species include a dwarf sperm whale (*Kogia sima*) that stranded on O‘ahu in 2000, predating the initial case of BWCV, and a false killer whale (*Pseudorca crassidens*), where the insular main Hawaiian Islands’ population is endangered. The results also broaden the known geographic range of BWCV to include Guam and Saipan in the Western Pacific and American Samoa in the South Pacific, where stranded Cuvier’s beaked whales (*Ziphius cavirostris*) tested positive. Additionally, coinfections of cetacean morbillivirus \((n=3)\), *Brucella ceti* \((n=1)\), and herpesvirus \((n=1)\) were found among the positive cases. Although the clinical significance is currently unknown, this project demonstrates that BWCV has a high prevalence within targeted screening efforts. Infectious diseases pose a major threat to cetaceans and BWCV may represent an important emerging disease within populations spanning the North, West, and South Pacific.

**Abundance and habitat selection of the West Indian manatee at the northern periphery of their expanding range**

Carl Cloyed\(^{1}\), Elizabeth Hieb\(^{2}\), Kayla DaCosta\(^{3}\), Ruth H. Carmichael\(^{4}\)

\(^{1}\)Dauphin Island Sea Lab, Dauphin Island, AL, \(^{2}\)Dauphin Island Sea Lab, \(^{3}\)Dauphin Island Sea Lab/University of South Alabama, \(^{4}\)Dauphin Island Sea Lab/ University of South Alabama, Dauphin Island, Alabama

Habitat selection during range expansion may facilitate movement into new geographic areas, shaping the trajectory of climate driven changes in distribution. The West Indian manatee is an ideal species to understand the influence of habitat selection on range expansion because their presence has rapidly increased during the past two decades in the northern Gulf of Mexico (nGoM), a region outside their historic range. We estimated manatee abundance in coastal Alabama waters from aerial surveys completed in 2010 and 2019 and used resource selection functions on tagged and opportunistically sighted manatees.
to quantify habitat use in local waters. We estimated ~ 25 and 34 manatees occupied coastal Alabama waters at any given time during the warm season (Apr-Nov) in 2010 and 2019, respectively. Manatees primarily used the Mobile-Tensaw River Delta and Dog River areas, and they selected nearshore, shallow water habitats proximate to submerged aquatic vegetation. Variables such as distance to boat ramp and human population density had a stronger effect in the sighted dataset but remained important in the tagged dataset, indicating that manatees used areas that overlapped with human activities. Temperature was a strong predictor of when manatees were sighted, with the highest probability of sighting occurring May-Nov when temperatures were > 20°C. These are the first estimates of manatee abundance and habitat use in the U.S., outside of Florida. Range expansion in manatees will likely be dependent on the availability of nearshore habitat with ample submerged vegetation, increased sea temperatures, and on manatee’s ability to migrate to those habitats when seasonally available. Environmental changes that decrease or increase these habitats and conditions can threaten or aid, respectively, manatee range expansion.

Insights into Foraging Behavior from Multi-day Sound Recording Tag Deployments on Cuvier’s Beaked Whales (Ziphius cavirostris) in the Southern California Bight
Shannon Coates1, Gregory Schorr2, Stephanie Watwood3, Brenda Rone4, Russel Andrews5, David Sweeney5, Mark Johnson6, Karin Dolan7, Stacy DeRuiter9
1Marine Ecology and Telemetry Research, Seabeck, WA, 2Marine Ecology & Telemetry Research, Seabeck, Washington, 3US Naval Undersea Warfare Center, Newport, Rhode Island, 4Marine Ecology & Telemetry Research, Seabeck, WA, 5Marine Ecology and Telemetry Research, Kingston, WA, 6Marine Ecology and Telemetry Research, Aarhus Institute of Advanced Studies, Aarhus University, Denmark, 7Naval Undersea Warfare Center, Newport, RI, 8Naval Undersea Warfare Center, Newport, RI, 9Calvin College, Grand Rapids, MI

Short-duration animal-borne sound recording tags have provided important information on the acoustic and foraging behavior of Cuvier’s beaked whales (Ziphius cavirostris). Longer duration recordings are needed to improve our understanding of both baseline and disturbed behavior. Here, we analyze over 400 hours of recordings from five Cuvier’s beaked whales tagged in the US Navy’s Southern California Anti-submarine Warfare Range with dart-attached Sound and Motion Recording and Transmitting tags (SMRT). Acoustic records of up to 5.9 days were recorded from a single tagged individual. Each SMRT tag’s audio files were manually reviewed using PAMGUARD’s spectrogram module to identify echolocation clicks from the tagged individual and potential anthropogenic sounds. Excluding foraging dives that had overlapping sonar or explosive detections, 258,522 tagged whale clicks from 99 foraging dives were identified. Daytime dives averaged 67.5 minutes in duration, 32.7 minutes of clicking, and 2,837 clicks (sd = 10.1, 6.7, and 529 respectively). At night, dives averaged 72.8 minutes, 28.9 minutes of clicking, and 2,390 clicks (sd = 11.8, 9.6, and 682 respectively). The percent time clicking, and the total number of clicks produced had a positive correlation with duration (r=0.54, p<0.01). Clicking started during descent at an average depth of 438 meters and ceased at 1,224 meters. Clicking generally commenced deeper at night than during daytime. Maximum foraging depth had a strong positive correlation with bottom depth (r=0.88, p<0.01), with foraging dives mostly reaching the bottom suggesting some benthic foraging. This dataset contributes to building a comprehensive understanding of Cuvier’s beaked whale foraging behavior across multiple days and will help to inform acoustic density estimations, inter-and intra-variation in foraging behavior, as well as foraging disruptions caused by exposure to Navy
sonar or other anthropogenic impacts.

**Diving behavior of humpback whales during their southbound migration in the Western South Atlantic Ocean**

Érika Coelho¹, Solene Derville², Vinicius Maia¹, Artur Andriolo³, Federico Sucunza³, Daniel Daniewicz³, Alexandre Zerbini⁷
¹Universidade Federal de Juiz de Fora - UFJF, Instituto Aqualie, Juiz de Fora, Minas Gerais, Brazil, ²Marine Mammal Institute, Oregon State University, Noumea, --- Select One ---, New Caledonia, ³Departamento de Ciências Florestais, Lavras, MG, Brazil, ⁴Departamento de Zoologia, Instituto de Ciências Biológicas, Juiz de Fora, Brazil, ⁵Federal University of Juiz de Fora, Juiz de Fora, Brazil, ⁶Grupo de Estudos de Mamíferos Aquáticos do RS, ⁷Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA

Environmental and social drivers of humpback whales, *Megaptera novaeangliae*, diving behavior during their migratory cycle is poorly known. In this study, we used satellite telemetry to investigate the diving behavior of individuals from the Western Atlantic Ocean population from their breeding grounds to their feeding grounds. Archival Argos satellite tags were deployed in 22 females with calf and 10 males off the coast of Brazil during the reproductive period. Tags reported data for an average of 44 days (max = 124 days) and yielded 92,058 dive records. Linear Mixed Effects Models revealed that average dive depth varied between habitats, being shallower in the breeding area (BA, 22.6 m), intermediate during the migration (MI, 30.2 m), and deeper in the feeding area (FA, 35.1 m). Average dive duration also varied between habitats: shorter at FA (2.49min), intermediate at BA (2.60min), and longer at MI (3.14min). Dives classified as shallow (<80 m) were more frequent at BA (99%), and Square-dives had the shallowest average at BA. Deep dives (>80 m) were more frequent (14%) during MI, and U-dives had the deepest average during MI. In the FA, dives during the night were shallower and shorter than those performed during the day, whereas in BA the dives were deeper during the day. Social classes (males vs females with calf) did not significantly influence dive depth and duration within the same habitat. The moon phases only affected dive depth in BA, as dives were on average shallower at the full moon. This study represents the first insights into the dive behaviors of individuals throughout their migratory cycle, which are shown to adapt their diving patterns in different habitats, shapes, diel phase, and moon phase. These findings have important implications for the ecological understanding of whale behavior and conservation policies in the region.

**Acoustic occurrence and movements of beluga whales in Kongsfjorden, Svalbard archipelago (Norway)**

Ilaria Coero Borga¹, Elena Papale², Giuseppa Buscaino³
¹Torino, Italy, Italy, ²Bioacoustics Lab, IAMC Capo Granitola, National Research Council, Torretta Granitola (TP), Italy, ³Torretta Granitola (TP), Italy

Beluga whales (*Delphinapterus leucas*) in the Svalbard archipelago (Norway) constitute an isolated sub-population made up of about 500 individuals, one of the smallest of the world. The species is strictly related to glacier fronts and fjords that it uses as a feeding area. In the light of climate change in the Arctic, the evaluation of the temporal presence of individuals along the months and the different light conditions, and their patterns of movement within the fjord become crucial for their conservation. Data were collected from April 2014 to August 2016 in Kongsfjorden with autonomous passive acoustic recorders at three sites: at the mouth of the fjord, in the middle in front of Ny-Ålesund village, and near the Kronebreen marine-terminating glacier. To assess the acoustic presence, 14371
recordings were analyzed both automatically and visually in the first site, in search of beluga whales’ clicks. 60 acoustic presences were detected, with no significant differences across months, and light conditions, but with higher presence rates in February, March, October and November, in autumn and in the dark condition. The number of counted clicks was in general agreement with the acoustic presences, with a slight difference in the monthly trend, showing an increase during August and September and a peak in October. Regarding the pattern of movement in the fjord, acoustic data did not show a recurrent path, even if the passage from the mouth to the middle of the inlet was the most frequent. Results suggest that beluga whales visit the fjord regularly, exploring the first side and possibly reaching the marine-terminating glacier when conditions are favorable. Other efforts are needed to understand the occurrence of the species in the area and the different factors that may affect their conservation.

The Cost of Diving Deep: High Resolution Tags Reveal the Effect of Dive Depth on Round-Trip Cost of Transport and Power in California Sea Lions (Zalophus californianus)

Mason Cole¹, Colin Ware², Elizabeth McHuron¹, Daniel Costa³, Paul Ponganis³, Birgitte McDonald⁶

¹Moss Landing Marine Laboratories, ²Center for Coastal and Ocean Mapping, University of New Hampshire, Durham, NH, ³University of Washington, Seattle, Washington, ⁴Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, ⁵Scripps Institution of Oceanography, La Jolla, CA, ⁶Moss Landing Marine Laboratories, Moss Landing, CA

Diving is central to the foraging strategies of many marine mammals and birds. Still, the effect of dive depth on foraging cost remains inconclusive because energy expenditure is difficult to measure at fine scales in wild animals. We used depth and acceleration data from 8 lactating California sea lions (Zalophus californianus) to investigate body density, fine-scale energy costs throughout vertical transit, and the effect of dive depth on the rate of energy expenditure. We calculated body density in 5s intervals from the rate of gliding descent. Using these data we modeled body density across depth for each sea lion, revealing high tissue densities and high but variable mean diving lung volumes. We estimated thrust and energy expenditure per second (P) in 5s intervals during descents and ascents using buoyancy derived from these models and drag calculated from swim speed. As expected, swimming thrust and P closely followed the influence of buoyancy at depth. Importantly, deeper dives required greater mean P, but lower mean Cost of Transport (COT; energy per distance) for round-trip vertical transit. Therefore, as dive depth increases, adult female sea lions cover distance more efficiently but spend energy at a faster rate. These trends appeared to be driven by increases in mean swim speed and mean hindrance due to buoyancy in deeper dives. Sea lions may therefore adjust swim speed to prioritize oxygen management (low COT) during deeper dives, and to prioritize overall savings in travel cost (low P) in shallower dives. This suggests deep diving is either a ‘high cost, high reward’ strategy, or an energetically expensive option to access prey when shallow prey are limited. These results add to our mechanistic understanding of how foraging strategy affects energy expenditure and life history and survival in wild breath-hold divers.

Modeling the impacts of human disturbance in cetaceans and pinnipeds: Do behavioral changes translate to disease consequences?

Melissa Collier¹, Shweta Bansal¹, Janet Mann¹, Sania Ali¹

¹Georgetown University, Washington, DC

At least two thirds of the marine environment is
currently being altered by human disturbances. Such disturbances alter animal behavior, with well-documented adverse consequences, included increase infectious disease transmission. Given the marked recent increase in marine mammal disease threats, we examine the link between human induced behavioral changes in marine mammals and their potential consequences for infectious disease. We (1) conducted a systematic literature review to determine how human disturbances change marine mammal behavior in ways that can impact disease spread, and (2) used a mathematical modeling framework to examine how these behavioral changes might influence potential epidemics. Our work highlights that human disturbances can influence marine mammal behavior in ways that increase their exposure (e.g. by increasing average group size) and susceptibility (e.g. through loss of energy from decreased resting, leading to immunosuppression) to pathogens, as well as their infectivity (e.g., through increased stress). We then consider the impact of these changes to pathogen exposure, susceptibility, and infectivity through epidemiological modeling in four different marine mammal case studies (California sea lions, *Zalophus californianus*; Australian humpback dolphins, *Sousa sahulensis*; killer whales, *Orcinus orca*; Indo-Pacific bottlenose dolphins, *Tursiops aduncus*). Our findings reveal that epidemics are predicted to be between 35-300% larger and 35-312% more likely to occur in the presence of disturbances, even when only a quarter or less of the population is affected. Considering the rate at which human disturbance is increasing in the marine environment, the number of threatened marine mammal species and populations, and the extent to which marine mammal disease is grossly underestimated, we advocate for the careful consideration of the indirect impacts of human disturbance on marine mammal health and disease.

The Effect of Sex, Age, and Calf Presence on the Rate of Shark Injury in Bottlenose Dolphins (*Tursiops aduncus*)

**Courtney Collins-Pisano**1, Vivienne Foroughirad2, Ewa Krzyszczyk3, Caitlin Karniski1, Janet Mann4

1*Wesleyan University, Westwood, MA,* 2*Georgetown University, MOREHEAD CITY, North Carolina,* 3*Georgetown university, WASHINGTON, DISTRICT OF COLUMBIA,* 4*Georgetown University, Washington, DC*

Dolphin mothers invest heavily in calves, including protecting them from shark predation. Previous research has shown that Indo-Pacific bottlenose dolphins in Shark Bay, Western Australia have high rates of non-lethal encounters with sharks, with 74% of individuals bearing at least one shark scar, mostly from tiger sharks. However, little is known about the demographic factors which may impact risk of non-lethal shark attacks. Female dolphins with dependent offspring are hypothesized to be more likely to sustain non-lethal shark wounds due to their interventions in attempted attacks on their calves. Using 32 years of longitudinal photo data, we determined whether a given dolphin was observed with a new shark wound in a given year. Sex, reproductive status, and calf presence were also recorded for each of 494 unique dolphins. A generalized linear model revealed no significant difference in the risk of non-lethal shark attack between females and males ($\beta=0.165, SE=0.137, p=0.229, N=1223$), but dolphins who are over 12 years old and considered sexually mature are significantly more likely to sustain a shark injury by a factor of 1.35 ($\beta=0.302, SE=0.092, p=0.001$), perhaps because these attacks are less likely to be lethal and thus observed. There is a significant cross-over interaction between sex and sexual maturity such that male dolphins have a higher risk of shark injury as juveniles, but female dolphins are more likely to experience a shark attack as mature adults ($\beta=-0.390, SE=0.137, p=0.005$). A second generalized linear model showed that calf
presence in a given year increases an adult female dolphin’s risk of shark injury by a factor of 1.54 ($\beta=0.432, \text{SE}=0.113, p=0.011, N=669$). Given other observations of mothers protecting calves from sharks, these results suggest that female dolphins’ risk of shark injury increases due to their efforts to protect their calf.

**Extended seasonal occurrence of coastal bottlenose dolphins (Tursiops truncatus) in the northern migratory extent of the Mid-Atlantic**

Kristi Collom1, Danielle Brown2, Rob DiGiovanni3, Kim Durham4, Arthur H (Artie) Kopelman5, Melissa Laurino6, Kate Lomac-MacNair7, Maria Maust-Mohl8, Maxine Montello9, Meghan Rickard10, Robert Schoelkopf11, Mari A. Smultea12, Troy Platt13, Ann Zoidis14, Jacalyn Toth Sullivan14

1Gotham Whale, Brooklyn, NY, 2Rutgers University, Neptune City, New Jersey, 3Atlantic Marine Conservation Society, 4Atlantic Marine Conservation Society, Hampton Bays, NY, 5Coastal Research and Education Society of Long Island, West Sayville, New York, 6Cape May Whale Watch and Research Center, Stockton University, Cape May, New Jersey, 7CCMAR, Universidade do Algarve, Fritz Creek, Alaska, 8Manhattan College, 9New York Marine Rescue Center, 10New York Natural Heritage Program; New York State Department of Environmental Conservation, Mount Sinai, NY, 11Marine Mammal Stranding Center, NJ, 12SES-Smultea Environmental Sciences LLC, Preston, Washington, 13Tetra Tech/ Cetos Research Organization / Allied Whale, Bar Harbor, Maine, 14Stockton University, Galloway, NJ

As monitoring efforts enhance our understanding of seasonal residency, movement patterns, and stock structure - population dynamics for coastal bottlenose dolphins (*Tursiops truncatus*) are frequently refined. Generalized across a broad migratory range, the North Atlantic Coastal Migratory Stock (NACMS) is a mosaic of seasonally resident and transient groups along the Eastern Coast of the United States where until recently, knowledge of regional stock variation was limited. The NACMS seasonal distribution is defined throughout southern New York and the northern Mid-Atlantic during Spring-Summer (April-October), with southern migration (southern Mid-Atlantic to Florida) during the late Autumn-Winter months (November-March). In the New York Bight, bottlenose dolphin sightings outside typical Spring-Summer residency was previously considered rare; however in recent years, the number of late Autumn-Winter sightings appears to be increasing. Our objective was to examine fluctuations of seasonal presence in NYB (Cape May, NJ to Montauk, Long Island) from November through March (“off-season”) with an emphasis on recent case studies of from 2020-2021. Sightings from local whale watch operations, citizen science platforms, marine rescue response reports, and aerial surveys were reviewed and will be summarized and discussed with relevance to cases of extended seasonal presence. Multiple “off season” observations in the NYB and surrounding estuaries (Shrewsbury River, NJ and Bellport Bay, NY) highlight the need to further investigate potentially shifting movement patterns and year-round presence of *T.truncatus* in the northern extent of this range. With a considerable increase in human activity (e.g., vessel traffic and offshore wind development) and respect to changing climate, it is important to monitor regional shifts in species occurrence. This review of NACMS off-season occurrence increases awareness of variability to established residency patterns, and may help improve coastal monitoring practices of this complex population of bottlenose dolphins in an area that is continuously evolving.

**Changes in Pinniped Prey Consumption along the West Coast of North America following Protection from Hunting and Culling**
Kate Colson¹, Andrew W. Trites²
¹University of British Columbia, Marine Mammal Research, West Suffield, Connecticut, ²UBC Marine Mammal Research Unit, Vancouver, British Columbia

Most seal and sea lion populations have grown considerably in North America following protection in the 1970s. However, their recovery has renewed concerns about fisheries competition and calls to resume culling despite uncertainty about how much prey pinnipeds consume and how their consumption has changed over time. Using new models of energy requirements paired with local abundance and diet data from the 1970s and the 2010s, we calculated consumption requirements in five regions between California and Alaska for 7 species of pinnipeds (California and Steller sea lions; Guadalupe and northern fur seals; harbour and northern elephant seals; and Pacific walrus). We found an overall 25% increase in abundance and consumption since the 1970s for all regions combined. This trend was largely driven by rising pinniped numbers in the southern and northern California Current as well as Southeast Alaska, while sharp declines occurred in the Gulf of Alaska and Bering Sea. The drop in pinniped numbers following the 1970s in the Gulf of Alaska and Bering Sea parallels a similar drop in mean diet energy densities in these regions. Further south, only northern elephant seals appear to have experienced a similar decline in their diet’s quality, as diet energy density increased for most other species in these regions. Dietary shifts to lower nutritional planes mean individuals now consume more biomass per day than during the 1970s to compensate for their diet’s lower caloric content, while those on higher nutritional planes currently consume less biomass per day. All told, our findings suggest that the assumed increase in pinniped consumption along the west coast of North America associated with population recovery from over-exploitation is an over-simplification. A more regional perspective must be used to describe historical changes in marine mammal consumption and provide a more local context to make informed fisheries management decisions.

From CARI’MAM project to a sustainable Caribbean network for marine mammal conservation
Gérald Mannaerts¹, Geraldine Conruyt², Claire Pusineri³, Magali Combes⁴, Jérôme Couvat, Sandrine Pivard
¹Agence française pour la biodiversité, Fort-de-France, Martinique, France, ²SPAW-RAC UN, basse terre, guadeloupe, France, ³SPAW RAC, Basse Terre, Guadeloupe, ⁴Agoa Sanctuary, Martinique

The three-year Caribbean Marine Mammals Preservation Network (CARI’MAM) project started in 2018. The project is funded by the EU, leaded by the Agoa sanctuary (French Antilles) and supported by the Specially Protected Areas and Wildlife Protocol (SPAW) of the Cartagena convention. Its aim is to strengthen marine mammal conservation in the Wider Caribbean Region through an enhanced cooperation among countries and territories. The network currently brings together more than 200 stakeholders, from 71 organizations and 20 countries and territories involved in the study and conservation of marine mammals in the Wider Caribbean Region. The presentation will give an overview the major project outputs: 1) a review of current threats and regulations related to marine mammals in the region and the identifications of priority areas for action (i.e. interaction between marine mammals and fisheries, contaminants, acoustic disturbance, vessel strikes, knowledge enhancement, and the development of national action plans); 2) the development of networking tools (e.g. workshops for ideas and practices sharing, social networks and a website, online databases), 3) capacity building (e.g.: development of a tool to enhance the inclusion of marine mammal in MPA management plans, online courses on marine mammal study methods, organization of data
collection trainings); 4) tools for the development of a sustainable whale-watching (e.g. workshops and outreach tools on best practices, regulatory tools assessment); 5) knowledge enhancement programs (deployment of a hydrophone array and boat based campaigns). The project will end in 2021, so we are now aiming to integrate these first steps in a sustainable network to be endorsed by the Caribbean countries through the SPAW protocol governance. We are also raising fund to work on areas identified as a management priority.

Cuvier’s Beaked Whale Presence in the Southern Adriatic Sea
Alexandra Constaratas1, Draško Holcer2, Ana Sirović3
1Norwegian University of Science and Technology - NTNU, Trondheim, Norway, 2Blue World Institute of Marine Research and Conservation, Veli Lošinj, Croatia, 3Texas A&M University Galveston, Galveston

Cuvier’s beaked whale (Ziphius cavirostris, Cuvier, 1823) is a beaked whale that is present in the Mediterranean Sea at low densities and not uniformly across each area. However, stranding and sighting data reveal that this species has one of the largest predicted abundance of the Mediterranean Sea in the southern Adriatic Sea. To get a better understanding of Cuvier’s beaked whale presence in this region of the Mediterranean, we studied the occurrence and characteristics of the echolocation clicks produced by this species. The acoustic data were collected offshore Dubrovnik, Croatia, from October 2018 to December 2019 and from June to December 2020 using a High-frequency Acoustic Recording Package (HARP) deployed at 1,000 m depth. We used a two-step process consisting of a click detector and a click classifier to automatically evaluate click occurrence. The click detection was performed using a customized version of the SPICE detector. The click classification was based on a Convolutional Neural Network (CNN) algorithm trained and tested using a dataset based on three parameters: a peak energy frequency interval, a time interval around the peak click duration, and a time interval around the usual inter-click interval (ICI) duration for Cuvier’s beaked whale. Our recordings indicate that Cuvier’s beaked whales are irregularly present in the South Adriatic Pit, the deep, southern region of the Adriatic Sea.

Detection of Rice’s whale calls in the Gulf of Mexico using passive acoustic data and deep learning
Ashley Cook1, Melissa Soldevilla2, Amanda Debich1, Kait Frasier2, Lance Garrison3, John Hildebrand4
1University of Miami, 2Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL, 3Cooperative Institute for Marine and Atmospheric Studies, University of Miami, Miami, FL, 4Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, 5Miami, FL

Rice’s whales (Balaenoptera ricei) are an endangered species with less than 100 individuals in their population and a habitat primarily limited to the northeastern region of the Gulf of Mexico (GoMx). Comprehensive long-term passive acoustic monitoring (PAM) studies are being conducted to understand this species’ distribution, seasonal occurrence, and movement patterns in their primary habitat. These large PAM datasets require robust and reliable automated methods to detect Rice’s whale calls to accurately describe their presence. However, commonly used automated detection and classification algorithms have high false positive rates caused by anthropogenic noise sources common to the GoMx. Deep learning methods can facilitate call detection and classification by reducing error rates and increasing the accuracy and speed of the identification process. This study develops a Convolutional Neural Network
(CNN) in the Python-based Ketos deep learning package to detect Rice’s whale long moan calls and downsweep pulse sequences and compares results with those of a spectrogram correlation detector. Rice’s whale calls were manually detected in 209 hours of randomly subsampled HARP recordings deployed in the Rice’s whale core habitat from August 2015 through May 2016 for use in training and testing call detection algorithms. Annotated images of spectrograms with 256 point FFTs and 0% overlap were created for 1,753 labeled long-moan calls, 87 labeled downsweep sequences, and 1,840 labeled noise periods. These annotated data were used to create and train the CNN using a ResNet-34 architecture, which is a popular architecture for image recognition. The ResNet classifier was trained using 70% of the generated spectrograms in the dataset and tested on the remaining 30%. Performance of the spectrogram correlation and deep CNN detectors are compared using precision and recall metrics to determine the best detector for evaluating Rice’s whales' seasonal and interannual occurrence patterns in their core habitat.

Marine Mammal Strandings in Monterey County, California: Insights from a Long-Term Dataset and the Case for University-Based Stranding Response Programs

Lauren Cooley¹, Birgitte McDonald², James Harvey³

¹Moss Landing Marine Laboratories, Marina, CA, ²Moss Landing Marine Laboratories, Moss Landing, CA, ³Moss Landing Marine Laboratories, Moss Landing, California

Marine mammal strandings provide a unique opportunity to collect morphological, taxonomic, and life history data from otherwise elusive species. These data are typically collected by researchers and volunteers from stranding networks comprised of local stranding response programs organized by NGOs, universities, and government agencies. Despite the valuable scientific contributions made by these programs, many are plagued by similar issues including lack of funding, resources, and trained personnel. One model that can help reduce these issues is the university-based stranding program. A case study of the Moss Landing Marine Laboratories (MLML) Marine Mammal Stranding Program shows that this model is mutually beneficial for both the host university and the stranding network. Since 1989, students from MLML, a California State University marine lab, have collected data from deceased marine mammals in Monterey County, California. The network benefits from the large pool of students eager to gain research experience, university facilities including freezer and lab space, expertise in marine mammalogy, impetus to publish results, and institutional name recognition. In turn, the university benefits from the student fieldwork opportunities, grant income, and available datasets for class projects and theses. To highlight the value of such long-term datasets, we reviewed the records of all dead stranded pinnipeds and cetaceans (n=3,182) documented by the MLML Stranding Program from 1996-2020. We observed 25 total species, with pinnipeds (n=2,915; 91.6%) stranding more frequently than cetaceans (n=267; 8.4%). The California sea lion (Zalophus californianus, n=2,130; 66.9%) was the most frequently stranded species, while seven species were documented only once in 25 years. MLML researchers also contributed to 12 Unusual Mortality Event investigations and helped describe a new species of beaked whale (Mesoplodon perrini). Looking to the future, the university-based stranding program model offers a well-validated framework to strengthen and expand global stranding networks, particularly those in understudied geographic regions.

Old tools, new tricks: Integrating traditional maritime technologies for an initial assessment of underwater noise from common vessels in San Francisco Bay

[...remainder of text...]
Cetacean presence has been growing in San Francisco Bay (SFB), but there has been an unusually high number of grey whale mortalities observed on SFB shores, with some linked to vessel strike injuries. Marine mammals that enter SFB are surrounded by a heavily urbanized coastline containing six of California's eleven major seaports and thus face a suite of synergistic threats where potential habitat overlaps with commercial shipping, high-speed ferry services, and pervasive recreational traffic. Smaller vessels not required to broadcast data via the Automatic Identification System (AIS) can contribute significant noise to urbanized coastal areas like SFB. The Marine Monitor (M2) uses marine radar linked with a high-definition camera, common maritime surveillance tools, to autonomously track vessels regardless of their participation in tracking systems. Data broadcast from vessels equipped with AIS are also integrated into the M2 system to supplement a detailed picture of all vessels on the water. M2 tracked vessels in a region of Central SFB to assess their contributions to underwater noise. Acoustic data were collected with a co-located hydrophone, and source levels (SL) were calculated for 565 unique vessel passages. Resultant cumulative daily sound exposure levels were modeled across the study area to evaluate the spatial footprint of noise levels over time. While large ships expectedly had the highest SLs, ferries and motorized recreational craft contributed noise to a greater area in two frequency bands of interest, highlighting the need to include these vessels when evaluating the overall impact on cetaceans. By utilizing tools integrated by the M2 system, data were collected autonomously without the need for an on-site observer facilitating a systematic analysis of all relevant vessels. These results can inform habitat quality and threat evaluation for species along urban coastlines.

Orca (Orcinus orca) social networks change over time at Punta Norte, Península Valdés, Argentina

Juan Copello1, Elizabeth Ashley2, Jorge Cazenave1, joseph Gaydos3, Diego Montecino-Latorre4, Marcela Uhart5, Ingrid Visser6
1Punta Norte Orca Research, Chubut, Argentina, 2UC Davis University, 3UC Davis School of Veterinary Medicine, Eastsound, WA, 4Wildlife Conservation Society, 5University of California, Davis and Universidad del Centro de la Provincia de Buenos Aires, Argentina, Puerto Madryn, Chubut, Argentina, 6Orca Research Trust, Tutukaka, New Zealand, New Zealand

Long term stable group cohesion has been documented in numerous distinct orca populations, although individual dispersal and group fission have occasionally been described. We investigated social structure and connectivity within a small group of orcas that intentionally strand to capture pinnipeds on the beaches of Punta Norte at Peninsula Valdés, Argentina. Sighting data collected during the season when they hunt southern sea lion pups at Punta Norte (March-April) from 2007 through 2019, were used to assess individual temporal dynamics and changes in individual sub-group associations and to identify periods in which specific subsets of orca were observed. Time-specific populations were identified using orca composition that were clearly different with respect to other years. Thirty-three individuals were observed during 310 unique sighting dates, resulting in 3,897 non-independent observations. Group dynamics changed over three time periods, 2007-2010, 2011-2014, and 2015-2019, with specific
community structures seen in each period. Group size varied from single to seven individuals and the number of groups varied from two to six. Despite being long-lived animals, social dynamics for this population changed over relatively short time periods. The data support that the animals within a unit were not randomly contacting each other, but actually forming communities, which were dynamic. It is not clear if social structures are maintained during times of the year when the orca are not intentionally stranding to predate southern sea lion pups, however within the three time periods, upon their return each season, most of the prior associations between the orca were still intact. These orcas have a very distinctive hunting method and it is possible that predation could be driving social organization of this ecotype.

Variation in social structure of two different stocks of island-associated bottlenose dolphins (Tursiops truncatus) around the main Hawaiian Islands
Enrico Corsi1, Robin Baird2, Annette Harnish3, Antoinette Gorgone1, Jeremy Kiszka4
1Florida International University, Olympia, WA, 2Cascadia Research Collective, Olympia, WA, 3University of Miami-CIMAS, NOAA Fisheries Southeast Fisheries Science Center Beaufort, USA, Beaufort, North Carolina, 4Florida International University, North Miami, Florida

Acoustic survey of marine mammals and anthropogenic underwater noise off the Southern coast of Southampton Island, Hudson Bay
Veronica Coppolaro1, Marianne Marcoux2, CJ Mundy3
1University of Manitoba, Siena, Italy, Italy,
2Fisheries and Oceans Canada, Winnipeg, Manitoba, 3University of Manitoba, Winnipeg, MB

Decreasing sea ice and prolonged sea ice-free periods are affecting ship traffic in the Arctic. The number of marine vessels is consistently increasing in the Canadian Arctic, including around Southampton Island. Fisheries and Oceans Canada recognized this area as an important migration route for the Eastern Canada-West Greenland bowhead whale (Balaena mysticetus) and the Western Hudson Bay beluga whale (Delphinapterus leucas), and as summer and wintering grounds for the Central-Low Arctic walrus (Odobenus rosmarus). Narwhals (Monodon monoceros), killer whales (Orcinus orca), and bearded seals (Erignathus barbatus) also use this area. Given the significance and the increasing pressure on this marine ecosystem, it is important to understand how the increment in human activities will influence marine mammals in the area. This work presents the analysis of underwater acoustic recordings collected South of Southampton Island between June and December 2018. Recordings mainly include beluga, bearded seal, and walrus vocalizations, along with recurring vessel traffic noise. The detection seasonal trend agrees with beluga migration time and routes, and with resident pinniped movements linked to sea-ice cycles, as reported by both the literature and traditional local knowledge. Based on initial findings, resident pinnipeds seem to be more habituated to motorboat underwater noise compared to belugas; whereas all marine mammal species appear to either flee the area or stop vocalizing during the transit of larger vessels. A comparison with acoustic data collected the following summer in the same area provides first results of a multi-year survey of this ecologically important marine area. Finally, suggestions on future underwater bioacoustic monitoring strategies for this acoustically understudied area are also presented. This study will contribute to better understanding marine mammal presence and movements in Southern Hudson Bay, and assessing the influence that vessel traffic and marine exploitation may have on their populations.
Investigating social structure within and across populations is critical to understanding the population structure and drivers in habitat use and preference of species, including in marine ecosystems. Common bottlenose dolphins (*Tursiops truncatus*) around the main Hawaiian Islands form four stocks identified using genetic and photo-identification methods, and have a distribution generally restricted to shallow waters (< 500 meters deep). A recent examination of abundance and trends indicate the Kaua‘i-Ni‘ihau stock may have undergone a decline and currently numbers about 112 individuals (CV=0.24), while the Hawai‘i Island stock numbers about 136 individuals (CV=0.43). The Hawai‘i Island stock is spread thinly over a much larger coastal area compared to the Kaua‘i-Ni‘ihau stock, as the two neighbouring islands are much smaller. Despite our knowledge of the two stocks’ abundance and population trends, we know little about their social structure and how it is affected by their environment. We compared the social structures of the two stocks to assess potential variation related to habitat. We used photo-identification data collected over 21 years (2000-2020) to investigate association patterns, using SOCPROG 2.9 and a half-weight index of association. We used permutation analysis to test whether social networks in both populations showed non-random association patterns. Results suggest strong, non-random association patterns. While average group sizes were similar between the two stocks (Kaua‘i-Ni‘ihau median=7, n=138; Hawai‘i Island median=6, n=127), Kaua‘i-Ni‘ihau’s dolphins formed looser associations with a higher overall number of affiliates compared to those off Hawai‘i Island. Our study highlights the potential role of suitable habitat size on the social structure of coastal dolphins. Future work will incorporate data from other islands, particularly to investigate the influence of habitat conditions and intrinsic population parameters (population size and trends) on the sociality of island-associated delphinids.

**Social behaviour of adult male sperm whales in polar waters when harassed by orcas**

Mel Cosentino¹, Sara Mesiti², Glenn Maan¹

¹Whalesafari Andenes, Aarhus, Denmark,
²Whalesafari Andenes, Andenes, Norway,
³Whalesafari Andenes, Andenes

Observations of orcas (*Orcinus orca*) predating on or harassing sperm whales (*Physeter macrocephalus*) are extremely rare, and, to date, there is no record in the literature such interactions with solitary adult males. Adult male sperm whales found in polar waters, such as off Andenes (Norway) are consistently seen alone and seldom in pairs. However, previous studies reported group formation when exposed to orca sounds during controlled experiments. Here, we describe the first observation of adult male sperm whales in polar waters and their social response to the interaction with orcas. The event took place on 23 July 2011, near a deep underwater canyon west of Andenes. The observation was made from a whale-watching vessel operated by Whalesafari Andenes. The data collected include behavioural data, videos, photographs, and acoustic recordings. First, a group of orcas were seen harassing a Minke whale (*Balaenoptera acutorostrata*) at a distance, when they changed their focus towards an adult male sperm whale who was resting at the surface. At this point, the male starts showing clear signs of distress, moving erratically and changing its heading. Soon after another male appeared on the surface and quickly approached the first animal. A third animal appeared afterwards, who also made a fast approach. All three aligned in a defensive position while orca seemed to harass them underwater as they were out of sight. Aerial displays were seen, such as taking the head out of the water and rolling. Sperm whale social sounds were also recorded during this event, suggesting communication between the males. The entire event lasted approximately 40 minutes and ended when the three sperm whales dived without showing their flukes. This is the first ever reported interaction between orcas and adult
male sperm whales anywhere in the world providing unique insights about these unusual events.

The common bottlenose dolphin (Tursiops truncatus) ecotypes of the western North Atlantic revisited: An integrative taxonomic investigation supports the presence of distinct species

Ana Costa¹, Wayne McFee², Lynsey Wilcox³, Frederick (Eric) Archer⁴, Patricia Rosel⁵
¹University of Miami, Florianopolis, Santa Catarina, Brazil, ²NOAA, Charleston, South Carolina, ³NOAA Fisheries, Southeast Fisheries Science Center, Lafayette, LA, ⁴Southwest Fisheries Science Center, La Jolla, California, ⁵NOAA Fisheries, Lafayette, Louisiana

Integrative taxonomy can help us better understand the taxonomic status of common bottlenose dolphin ecotypes (coastal and offshore), Tursiops truncatus, in the western North Atlantic (wNA). Previous genetic findings suggested these ecotypes could be different species; nevertheless, their taxonomy remains unsettled. Using an interdisciplinary approach (i.e., comparative morphology, traditional and geometric morphometrics, mitochondrial DNA, nuclear DNA), we evaluated the evolutionary relationships between these two ecotypes as well as their relationships to bottlenose dolphins found worldwide, to help clarify their taxonomic status. A morphological comparison of the wNA ecotypes was conducted using up to 149 samples (including the holotypes of two synonymized nominal species in the wNA: T. erebennus and T. subridens), while genetic analyses were performed for 79 of these 149 individuals. For the worldwide comparisons, we compared the wNA morphological data with T. truncatus samples collected worldwide (n = 169; including the T. truncatus holotype). We also investigated phylogenetic relationships using a subset of the wNA data set (n = 27 haplotypes) and 222 Tursiops sp. haplotypes representing 12 oceanographic regions. We observed congruence between the different data sets, reinforcing the wNA ecotypes are following distinct evolutionary trajectories. Based on the mtDNA analyses, we detected significant genetic divergence (dₛ = 0.027), high diagnosability (PD = 100%), no shared haplotypes, and one fixed difference between the two ecotypes in the wNA. We also found negligible nuclear gene flow and diagnosable morphological characters (skull) between them. Worldwide comparisons indicated the offshore dolphins form a relatively cohesive worldwide unit (T. truncatus). Multiple lines of evidence indicate the coastal ecotype in the wNA is an independent evolutionary unit. We propose it be recognized as a distinct species and resurrect the name T. erebennus.

Matching Proximate with Ultimate Processes: Elephant seals a model system

Daniel Costa¹, Roxanne Beltran², Rachel Holser¹, Patrick Robinson¹, Daniel Crocker¹, Stephanie Admaczak³
¹Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, ²University of California Santa Cruz, Felton, CA, ³University of California, Santa Cruz, Santa Cruz, CA, ⁴Sonoma State University, Rohnert Park, CA, ⁵University of California at Santa Cruz, SANTA CRUZ, CA

A fundamental challenge in ecology is linking short-term processes with population consequences. One common approach uses bioenergetics models to identify the vital rate costs associated with specific behaviors or responses. A critical but understudied component of these models is the body condition parameters associated with survival and reproduction. Using 17-years of tracking data on female northern elephant seals (n =480), we compared age, body mass, and blubber mass at departure and arrival, along with the date of departure and arrival from their post-molt and post-breeding foraging migrations. There were no significant differences
between years in departure mass, arrival mass, mass gain, or percent mass gain during post-molt foraging trips. Age and body mass were strongly correlated for all seasons. However, age and body condition were only weakly correlated at the end of the molt. The number of females who failed to pup increased across the study period, driven by a significant mortality increase. On average, 13% of instrumented females did not pup each year, which was independent of year or age. Both year and age influenced the probability of mortality at sea, with higher mortality in recent years and among young (4- to 6-year-old) females. Lower mass at departure was linked to higher at-sea mortality but not skip breeding. Larger females with more absolute adipose tissue had a greater probability of pupping than smaller females with less adipose tissue mass. However, the proportional amount of adipose tissue at arrival was not correlated with the likelihood that a female produced a pup. Lower mortality and higher reproductive success in older females is likely associated with experience and the greater resilience related to large size. Together, these data indicate that at least for capital breeding marine mammals bioenergetics model should incorporate size and experience when predicting fitness consequences of disturbance.

First report of pilot whale morbillivirus in South hemisphere

Samira Costa-Silva1, Carlos Sacristán2, Rodrigo Soares3, Vitor Carvalho Luz4, Pedro Castilho5, Marta Cremer6, Pedro Navas-Suárez7, Thalita Faita8, Aricia Duarte Benvenuto9, Ana Carolina Ewbank, Marina K. Ramos10, Nicole Nigro10, Caroline F. Alves10, Jenyffer Vieira10, Giulia G. Lemos10, Natalia Silvestre-Perez, José Luiz Cetacean morbillivirus (CeMV, family Paramyxoviridae, genus Morbillivirus) infection is an important cause of mortality in cetaceans. Among the CeMV lineages, the pilot whale morbillivirus (PWMV), initially described in New Jersey (USA), has been detected in four pilot whales, in the Northern Hemisphere. In 2020, four short-finned pilot whales (Globicephala macrorhynchus) stranded in Brazil, in the states of Ceará (case 1 and 2) and Santa Catarina (case 3 and 4). Following necropsy, samples were fixed in 10% buffered formalin for histopathology and frozen at – 80 ºC for molecular diagnosis. Morbillivirus detection was performed using a two-step nested PCR to amplify a 419 bp fragment of the phosphoprotein gene. Additionally, herpesvirus detection was performed in lung (n=2) and liver (n=4) samples using pan-PCR protocols. All available tissues were tested for morbillivirus. Three animals were PWMV-positive, in central nervous system (cerebellum 1/3, liquor 1/2, spinal cord 2/3 and/or brain 1/4). Additionally, case 4 was positive in pulmonary lymph node. The PWMV-negative case was a newborn (Case 2). Grossly, all PWMV-positive animals were cachectic and
had interstitial pneumonia. Case 1 presented meningoencephalitis, sinusitis, parasites in pterygoid sinus and pyelonephritis. An alphaherpesvirus was detected in Case 3. The obtained PWMV consensus sequence had 99% identity with a sequence from the Canary Islands (KT006290). All PWMV positive cetaceans from Brazil were juveniles. Immunohistochemistry studies will be performed to evaluate the viral distribution. This is the first report of PWMV in South America and the first coinfection of alphaherpesvirus and CeMV described in cetaceans from the Southern Hemisphere. Our work broadens the distribution range of PWMV and suggests that this lineage is also circulating in South American pilot whales and that this strain might be enzootic in Globicephala genus. Additional studies are necessary to understand the impact and epidemiology of PWMV in the southern Atlantic Ocean.

Comparison of Arterial and Venous Blood Oxygen Loading and Unloading in Free-Ranging Dives and Terrestrial Sleep Apneas from Northern Elephant Seals (Mirounga angustirostris)
Alicia Cotoia¹, Paul Ponganis², Jessica Meir², Michael Tift³
¹University of North Carolina Wilmington, Wilmington, North Carolina, ²Scripps Institution of Oceanography, La Jolla, CA, ³University of North Carolina, Wilmington, Wilmington, North Carolina

Northern elephant seals (Mirounga angustirostris) have enlarged blood oxygen stores that play an essential role in extending the duration animals can spend utilizing aerobic metabolism during breath holds. It is hypothesized that the animals deplete blood oxygen stores more rapidly during terrestrial apneas, compared to dives, based on diving bradycardia being more intense than terrestrial apneas. However, blood oxygen depletion rates have never been compared in the same individuals experiencing the two breath-hold types. Further, it’s unknown how blood oxygen depletion rates vary between the two breath-hold types of similar duration and between arterial and venous blood stores. To study this, partial pressure of oxygen (PO₂) was continuously recorded in the brachial/femoral artery (n=4), extradural vein (n=3), or hepatic sinus (n=4) of 11 juvenile elephant seals during terrestrial sleep apneas and while the animals were freely diving at sea. Initial, maximum, final, and minimum PO₂ values and their respective times during breath-holds were extracted for each recorded dive/apnea (ranging from 1-11 minutes). Using previously published Hb-O₂ dissociation curves, all PO₂ values were converted to hemoglobin saturation (SO₂) values using a pH of 7.4. Initial arterial SO₂ was consistently similar between dives and apneas, while initial SO₂ during dives were lower in the extradural vein and hepatic sinus when compared to terrestrial apneas. Final SO₂ remained similar between arterial and hepatic sinus blood of both breath-hold types, but was consistently lower in the extradural vein during dives. Diving and apneas resulted in similar depletion rates in the artery and hepatic sinus, but a faster depletion rate in the extradural vein was consistently seen during dives. These patterns highlight unique differences in venous and arterial oxygen loading and unloading between dives and terrestrial apneas in northern elephant seals.

Persistent Organic Pollutant Extraction from Marine Mammal Keratinous Tissues
Briana Coulter¹, Dimitrios Giarikos², Jessica Brown³, Alydia Moorhead⁴, Amy C. Hirons⁵
¹Nova Southeastern University, Plantation, Florida, ²Nova Southeastern University, Ft. Lauderdale, ³Nova Southeastern University, ⁴Nova Southeastern University, Dania Beach, FL

Persistent organic pollutants (POPs) and their resistance to degradation, ability to bioaccumulate, and persistence in the marine
environment has been a focus of research since their introduction and use in the 1940s. Previous research has successfully quantified POP concentrations in marine mammal muscle, blubber, liver, and kidney, with the exception of keratinous tissues. Keratinous tissues, like vibrissae and baleen plates, are continuously growing, providing a timeline of POP data for individuals. This study has successfully quantified insecticides including, hexachlorocyclohexanes (HCHs) and dichlorodiphenyltrichloroethanes (DDTs), as well as multi-use chemicals like polychlorinated biphenyls (PCBs) from walrus (Odobenus rosmarus) vibrissae collected in 1995 from Cape Pierce, Alaska which are benthic foragers, feeding primarily on benthic bivalves. Multiple methodologies were used to determine the best extraction method which yields the widest POP ranges and greatest concentrations. An acid digestion method proved to be the most effective, yielding ten different organic contaminants from O. rosmarus vibrissae. \( \alpha \)-, \( \beta \)-, and \( \gamma \)-HCH values ranged from 18.61 ng/g to 106.51 ng/g. Pesticides like, 4, 4’-DDE, Heptachlor, Heptachlor epoxide, Aldrin, Dieldrin, and Endrin ranged from 1.72 ng/g to 61.27 ng/g. PCB congeners 52, 101, 153 and 209 ranged from 1.16 ng/g to 3.78 ng/g. Continued research is focused on quantifying organic contaminant concentrations using the same extraction method from gray whale (Eschrichtius robustus) and bowhead whale (Balaena mysticetus) baleen plates. Similar to O. rosmarus, E. robustus are benthic foragers feeding primarily on benthic amphipods. However, B. mysticetus are a neritic forager, feeding primarily on zooplankton. POPs are predominately incorporated into organism tissue through prey consumption. Analyzing POP concentrations among multiple foraging strategies for an extended timescale can provide insight into POP pathways and assimilation.

More Bang for the Buck: Opportunities for Marine Mammal Conservation as Part of Offshore Wind Mitigation in the US
Sarah Courbis\(^1\), Koen Broker\(^2\), Louis Brzuzy\(^3\)
\(^1\)Advisian Worley Group, Portland, Oregon, \(^2\)Shell New Energies, Houston, TX, \(^3\)Shell New Energies, Unionville, IN

Under the US Marine Mammal Protection Act, activities that may harass marine mammals undergo permitting that requires harassment of only “small numbers” and “negligible impacts.” Because of the “small numbers” requirement, permit applicants develop models to assess numbers of individuals that may be harassed. Likely because of the quantitative nature of “small numbers,” offset mitigation has rarely, if ever, been applied as part of authorizations. In the Gulf of Mexico, a risk framework was applied by NMFS that considered potential for auditory injury in the context of potential biological removal (PBR). There is not an equivalence between behavioral changes and PBR, as responses don’t directly translate into mortality; however, actions directed at reducing lethal impacts, such as fisheries entanglements or vessel strikes, are more likely to benefit marine mammal fitness, particularly for endangered stocks, than extensive mitigation directed at reducing the harassment impacts. In the US, offshore wind companies are proposing expensive and complex mitigation and monitoring to achieve “small numbers,” particularly around sound management during installation. Although sound is an important stressor, we suggest that cost and effort toward offset mitigation would be of greater value to many stocks and should be considered as an alternative to achieve permit findings. For example, a risk assessment framework could be applied to determine estimated reduction in lethal interactions of right whales with trap gear in relation to an offset that provides ropeless gear. The challenge of offset mitigation is quantification of the offset relative to the impact. We can learn from offset precedents used for
other statutes. Probabilistic models and expert elicitation are approaches to quantify offsets and create a suite of options. We will make a case that equivalent-cost offset mitigation in place of some direct mitigation would maximize conservation benefits to marine mammals as part of offshore wind development.

**Microplastics in the Gastrointestinal Tracts of Odontocetes in the Southeast Region of the United States**

**Julia Courville**, Gretchen Bielmyer-Fraser

`Jacksonville University, Alameda, CA`

Globally, microplastics (<5 mm in diameter) comprise approximately 92% of all plastic marine debris. Despite this extensive proportion, the subject of microplastics in marine mammals is vastly understudied. An increasing body of research in recent years is contributing to the emerging documentation of the microplastic profile of odontocetes living in the coastal Southeastern region of the United States. This study includes the following specimens: twenty-three bottlenose dolphins (*Tursiops truncatus*) stranded in Texas, Alabama, Puerto Rico and Florida plus one pygmy sperm whale (*Kogia breviceps*) and one pantropical spotted dolphin (*Stenella attenuata*) from Southern Florida, and one short-snouted spinner dolphin (*Stenella clymene*) from Texas. Contents found in various portions of the gastrointestinal (GI) tracts, namely, stomach chambers and intestines, were subjected to a laboratory procedure to isolate existing plastics. This process involved washing and sieving GI contents followed by filtering and separating the material to retrieve size fractions between 0.125 mm and 5 mm. The suspected microplastics were analyzed by physical characteristics under a stereomicroscope and polymer classifications verified via Fourier Transformed Infrared Spectroscopy. It is hypothesized that each specimen will contain an array of microplastics with physical characteristics distinguished by the following: polymer, quantity, shape, and color. Documenting and understanding the microplastic content in both deep diving and shallow diving odontocetes will strengthen the current knowledge of microplastic loading. This project assesses exposure and accumulation of microplastics within the GI tracts of odontocetes, setting the stage for future pertinent research.

**A democratic large scale high sampling rate bioacoustic observatory through the CARI’MAM network**

**Gerald Mannaerts**, Hervé Glotin, Valentin Gies, Jérôme Couvat

`Agoa Sanctuary, Trois-Ilets, Martinique; SMIOT, Université de Toulon, Toulon, France; EDAM MADICS CNRS, Marseille, France; Aix Marseille Université, Université de Toulon, CNRS, ENSAM, LSIS UMR 7296, Marseille, France; BRILLAM STICAmSud, Toulon, Var, France; ’Aix Marseille Université, Université de Toulon, CNRS, IM2NP UMR; EDAM MADICS CNRS; SMIOT, Université de Toulon; BRILAAM STICAmSud, Toulon, Var, France; ’Agoa sanctuary, Martinique`

The CARI’MAM project (2018-2021) aims to enhance the connection between marine mammals conservationist throughout the Caribbean thanks to exchanges, workshops, surveys and common analysis. One of the main actions of this project is the deployment for one year of almost twenty hydrophones in the Great Caribbean Region, between Bermuda in the North and Bonaire in the South, and between Jamaica in the West and Martinique in the East. This project is led by the French Biodiversity Agency trough the Agoa Sanctuary and the partners from each island are local NGOs and marine protected areas managers. Beyond the objective of networking and capacity building, the goal of this survey is to increase the knowledge about spatial and temporal repartition of marine mammals in the region and ultimately inform conservation policies.
The versatile low power and low cost high velocity recorder, called "Jason HighBlue" has been tailor-made and is distributed by LIS IM2NP CNRS and the “Scientific Microsystems for Internet of Things” Platform of the University of Toulon. It can record marine sounds from a large bandwidth (here set to 256 kHz SR, 500 Go Storage, 5 Hz to 125 kHz bandwidth), encompassing the 20 cetacean species present in the region[1]. It is scheduled to record several minutes an hour, each day during sessions of 40 days using 21 D batteries. These data are analyzed progressively trough deep learning algorithms by the LIS DYNI CNRS team at University of Toulon holding the national Chair of Artificial Intelligence for bioacoustics ADSIL. The probabilities of detections aim to build the first dynamic mapping of the movement of the cetacean populations at the Caribbean scale (5 000 km long).

[1] Samples of recordings and documentation on Jason HighBlue are available at http://sabiod.org/pub/CARIMAM

New Insights on the Evolution of Form and Function of the Florida Manatee Spermatozoon
Jonathan Cowart1, Danielle Collins2, Daniel Stanton2, Gerhard van der Horst1, Iskande Larkin4
1University of Florida, 2Department of Animal Sciences, College of Agricultural and Life Sciences, University of Florida, Gainesville, Florida, 3Department of Medical Bioscience, University of the Western Cape, Belville, South Africa, 4University of Florida, Gainesville, Florida

Sperm morphology, including morphometry and structure, is highly variable across mammalian taxa with sexual selective pressures regarded as the primary driving forces of sperm morphological diversity. The morphological and structural organization of the spermatozoon provides essential information about: (1) the functional roles of each spermatozoal component, (2) their potential relationship with reproductive success, and (3) the evolutionary influence of sexual selective pressures on sperm morphology. To better understand how a promiscuous mating system may influence sperm morphology in Florida manatees (Trichechus manatus latirostris), we investigated sperm morphometry, ultrastructure, and cytoskeletal components of sperm retrieved postmortem from the vas deferens of nine recently deceased Florida manatees. Sperm were analyzed by automated sperm morphometry analysis (ASMA), electron microscopy, and laser-scanning confocal microscopy (LCSM). The morphometric parameters analyzed in this study were approximately 1.5-2 times larger than those previously reported for the Florida manatee. The midpiece was large containing approximately 84-90 mitochondria. Preliminary measurements of midpiece volume correlated closely with other species that exhibit a multi-partner mating system. Additionally, there was distinct enlargement of outer dense fibers (ODFs) 1,5,6, and 9, which were uniquely elongated and rectangular in shape. The enlargement of four ODFs may function to better stabilize the sperm flagellum and enhance sperm velocity. Lastly, cytoskeletal elements (F-actin filaments and alpha-tubulin microtubules) displayed moderate localization within the spermatozoon head with strong localization of F-actin at the interface of the head and connecting piece and strong localization of alpha-tubulin within the midpiece. The results of this study provide new insights on the potential link between form and function of Florida manatee sperm, which seemingly adds mounting evidence for the potential occurrence of sperm competition within this species resulting from a promiscuous mating system.

Temporal Trends of Begging Behavior in Individual Common Bottlenose Dolphins (Tursiops truncatus)
Graham Derzon-Supplee1, Robin Perrtree2,
Extinction of conditioned behaviors is difficult to achieve when positive reinforcement is variable. In some locations, common bottlenose dolphin (Tursiops truncatus) living along coastal areas have been conditioned to beg humans for food. Because positive reinforcement of receiving food in these areas is likely variable, extinguishing the behavior through education and outreach of humans is difficult. Savannah, Georgia, USA has the highest rates of dolphin begging in the world. After community outreach programs were implemented in Savannah in 2010, the proportion of dolphin sightings with begging observed declined from 22.5% in 2010 to 7.5% in 2016. We examined temporal patterns of individual dolphin begging behavior near Savannah to understand whether this decline was mostly due to cessation of begging by individual dolphins, death or emigration of begging dolphins, or reduced rates of beggar recruitment. Data were collected from May 2009 to May 2016 via boat-based surveys in waterways near Savannah and subsequent photo-identification. Begging histories were created for 105 dolphins sighted 20 or more times in this time frame. Of 105 dolphins, 50 (48%) begged at least once. Of those, 12 (24%) ceased begging by 2012, and 31 (62%) ceased by 2014. Begging recruitment sightings, i.e., the first time a dolphin was seen begging, declined from 9 in 2010 to 1 in 2016. Two dolphins that accounted for 9% of begging sightings from 2009-2014 disappeared in 2014. Individual begging cessations contributed to the begging rate decline between 2010 and 2016, and to a larger degree than did dolphin disappearance and lowered recruitment rates. This study suggests that begging, a conditioned behavior which yields unpredictable rewards, is being extinguished in dolphins near Savannah, Georgia, USA. The apparent success of Savannah’s outreach programs in curbing dolphin begging behavior can be cited and replicated by dolphin conservationists worldwide when implementing community education initiatives.

Gossip in the deep: Social calls recorded from Baird’s beaked whales

Jessica Crance¹, Koji Matsuoka²
¹Marine Mammal Laboratory, Shoreline, Washington, ²Tokyo, Japan

While a lot of studies have described their echolocation signals in detail, there are very few reports on social sounds produced by Baird’s beaked whales (Berardius bairdii). The IWC-POWER (Pacific Ocean Whale and Ecosystem Research) cruises in the North Pacific are a collaborative effort between the International Whaling Commission and the Government of Japan, with the main objective of obtaining information on abundance, distribution, and stock structure of large whales to inform conservation and management. Though primarily a visual line-transect survey, sonobuoys were deployed to acoustically monitor for marine mammals. The 2018 POWER cruise occurred from 16 July to 12 September in the central Bering Sea. Results presented here focus on the passive acoustic component. A total of 253 sonobuoys were deployed, for a total of 700 monitoring hours. On 23 August 2018 in the deep Bering Basin approximately 370 km north of Adak, AK, observers visually sighted a group of 17 individual Baird’s beaked whales that were milling at the surface. Opportunistic photo-identification photographs were collected. A sonobuoy was deployed to 300 m depth (sampling rate 48 kHz) within 0.7 km from the group after the animals dove, and acoustic recordings were collected for over an hour. The only other species visually observed in the vicinity was Dall’s porpoise; no other species were detected on the sonobuoy. Call types recorded include buzzes, clicks, whistles, and
pulsed calls, as well as call types that have not yet been documented for this species. Details on the acoustic parameters of these calls will be presented. These recordings will add to the known repertoire of Baird’s beaked whale vocalizations and aid future passive acoustic monitoring studies.

**Using Autonomous Underwater Vehicles to collect data on free-swimming cetaceans in the wild**

**Kirsten Crane¹, Per Berggren², Nick Wright³, Steve McGough⁴**

¹Newcastle University, Newcastle, United Kingdom, ²Newcastle University, School of Natural and Environmental Sciences, United Kingdom, ³Newcastle University, Newcastle Upon Tyne, Tyne and Wear, United Kingdom

Collecting underwater video and audio of free-ranging cetaceans in their natural habitat can greatly aid population management and conservation research. Full-body images and signature whistle recordings can provide information-rich data for identification of new or catalogued individuals, allowing for a better understanding of population counts, population dynamics etc. Underwater video footage is also useful for studying behaviour. Untethered, autonomous underwater vehicles (AUVs) allow for data collection at depth and potentially free from (or distanced from) the presence of a research vessel. The use of AUVs has proven successful in the study of other marine species but has typically involved tagging the animal to facilitate tracking via send-receive electronics. Here, we look at bringing autonomous control to the BlueROV2 commercial remote operated vehicle, with an active object tracking algorithm trained in simulation with vision-based deep reinforcement learning. To this end, we are developing SWiM-DEEPer (Simulated World for Marine Deep Learning) - a high-fidelity, 3D simulation complete with Gym wrapper SwimGym. Meanwhile, effective target following in two dimensions has been achieved in two stand-in simulations as an initial proof of concept, with a high level of behavioural influence afforded to the programmer e.g. stipulating an optimal target-tracker distance, constraining speed, constraining change to direction. These results demonstrate the viability of using an AUV, without tagging, to collect real-time visual and acoustic data for identification, for better understanding of social interactions, and for linking acoustic and behaviour information.

**Auditory Sensitivity and Directionality in Three Mysticete Species**

**Ted W. Cranford¹, Petr Krysl²**

¹San Diego, CA, ²University of California at San Diego, La Jolla, CA

Auditory frequency sensitivity and directionality are critical factors for survival in marine mammals. We developed the Vibroacoustic Toolkit (VATk), a set of tools that provides a means to simulate and visualize the biomechanical processes of mysticete sound reception, particularly for low-frequency (LF) sounds. The VATk combines CT scan data with elastic tissue properties and finite element modeling (FEM) techniques. X-ray computed tomography (CT) scanning produced density maps for three mysticetes, an entire minke whale (Balaenoptera acutorostrata), and two intact heads from a fin whale (Balaenoptera physalus) and a gray whale (Eschrichtius robustus). Applying various finite element modeling tools and techniques, including the VATk, have produced three significant discoveries: (1) the first computational audiograms for mysticetes; (2) evidence that bone conduction by vibrations through the skull is the primary mechanism for LF sound reception in mysticetes; and (3) LF sound reception in mysticetes is directional, but the specific underlying mechanism(s) are currently being examined.
Minke whales are known to produce pulsed sounds between 50 and 300 Hz, while their "boing" sounds occur between 1-2 kHz. Our computational audiogram for the minke whale covers both ranges, but also includes a prediction of increased sensitivity between 10-40 kHz. This relatively "high-frequency" sensitivity may offer some protection against killer whale predation. There is some evidence that gray whales also have "high-frequency" sensitivity across a similar range, which may also confer protection from predation pressure.

Our current hypothesis is that all cetacean heads function like acoustic antennas. Inputs to the ears are integrated over the entire head, although some vibrating regions contribute more to specific received frequency bands than do others.

Comparison of Total Mercury Concentration and Stable Isotope Ratios of Fur Collected from Two Body Regions in Individual Northern Fur Seals

Stephanie Crawford¹, Michelle Quillin¹, J Margaret Castellini¹, Carey Kuhn², Rolf Ream³, Tonya Zeppelin⁴, Lorrie Rea⁵


Mercury, a known neurotoxic contaminant, is well-documented in tissues of North Pacific pinnipeds. Concentrations vary greatly depending upon the geographic location and pinniped species sampled. We evaluated total mercury concentration ([THg], µg/g) in concert with stable isotope ratios of nitrogen (δ¹⁵N) and carbon (δ¹³C) which provide information regarding foraging habits at the time of fur growth. Fur is an ideal matrix for assessing THg for several reasons: excretory pathway for Hg, minimally invasive, simple to collect/analyze, relatively small quantity (~ 30g) required, and stable matrix allowing collection from live or dead animals. To determine the effect of body region on fur [THg], δ¹⁵N, and δ¹³C, samples were collected from two body regions of adult female northern fur seals (Callorhinus ursinus, n=28) on St. Paul Island, Pribilof Islands, Alaska during the breeding seasons of 2016, 2017, and 2019. Specifically, we compared [THg], δ¹⁵N, and δ¹³C in fur from the: 1) right dorsolateral hip (typical collection site) and 2) mid-central dorsum (recovered from instrument backings following removal from the seal’s pelage). Due to non-normality, a non-parametric Friedman test was used to test for differences between groups (repeated measures). No significant differences were found between body regions for δ¹³C (p=0.6266). Fur from the hip site was significantly higher in both δ¹⁵N (p=0.0256) and [THg] (p=0.0143) than the dorsum site. While statistically significant, absolute differences in δ¹⁵N (<2 units) and [THg] (1–4 µg/g) between body regions were relatively minor. All seal fur in this study was below the 20 µg/g THg published threshold of potential adverse effects.

Stomach content analysis reveals changes in ringed seal diet between a cold (2000–2013) and a warm regime (2014–2020) in Alaska

Justin Crawford¹, Lori Quakenbush¹, Louise Biderman, Anna Bryan¹, Ryan Adam

¹Alaska Department of Fish and Game, Fairbanks, Alaska, ²Alaska Dept. Fish and Game, Fairbanks, Alaska, ³Alaska Department of Fish and Game

Changes in sea ice and oceanographic conditions are altering the distribution and biomass of marine species and are predicted to alter the ice-adapted Pacific Arctic marine food web. Specifically, warm water tolerant species (e.g., saffron cod, Eleginus gracilis) are predicted to displace cold water tolerant species (e.g.,
Arctic cod, *Boreogadus saida*). To assess how these changes may affect the diet of upper-trophic marine predators, we compared stomach contents of 952 ringed seals (*Pusa hispida*) harvested in the Chukchi Sea, Alaska, between a cold (2000–2013) and a warm regime (2014–2020) and used logistic regression to test for changes in frequency of occurrence (%FO) of prey. Ringed seal diet in Alaska is known to differ seasonally between the ice-covered (November–May) and open-water (June–October) seasons as well as between non-pups (adults and subadults) and pups. Although the %FO of major prey items (%FO >25%) differed seasonally and between age classes, major prey items consumed by non-pup and pup ringed seals were remarkably similar and included: Arctic cod, saffron cod, rainbow smelt (*Osmerus mordax*), shrimp, amphipods, and mysids. We detected changes in diet between temperature regimes. During the warm regime, the %FO of Arctic cod decreased for all seasons and age classes while the %FO of saffron cod increased during the ice-covered season for non-pups but decreased during the open-water season for pups. Also during the open-water season, the %FO of rainbow smelt and capelin (*Mallotus villosus*) increased for non-pups. Overall, during the warm regime, the %FO of fish decreased in both seasons for pups. The %FO of invertebrates (shrimp and mysids) decreased in the open-water season only for non-pups, but amphipods decreased in all seasons for all ages. Continued sampling and analysis are necessary to monitor changes in ringed seal diet associated with ongoing climatic changes.

Evidence of the presence of nuclear-mitochondrial transfers (NUMTS) in Steller’s sea cows (*Hydrodamalis gigas*)

**Lorelei Crerar**¹, Gavriella Siman-Tov¹

¹George Mason University, Annandale, VA

Many mammal species demonstrate segments of deoxyribonucleic acid (DNA) which are copies of genes in the mitochondria (mtDNA) DNA that have migrated to the nucleus of the cell and joined to nuclear DNA (nDNA). This can cause the misidentification of DNA segments as mitochondrial when they are nuclear in origin. We extracted DNA from the bone of Steller’s sea cows (*Hydrodamalis gigas*) which contained these segments of DNA, known as nuclear-mitochondrial transfers (NUMTS). DNA was extracted from 175 bones originating on St. Lawrence Island, USA and one bone from Bering Island in Russia. The samples were amplified using the polymerase chain reaction (PCR) and sequenced. Of those samples, 10 contain NUMTS for the cytochrome *b* gene as identified by heterozygous segments located following sequencing. This discovery adds to the vast body of species in which NUMTS have been found. This experiment could be expanded to include the living relatives of the sea cow, the manatee (*Trichechus manatus*) and the dugong (*Dugong dugon*).

**Is a unified approach suitable for the conservation management of two endangered delphinid species in a semi-enclosed New Zealand sound?**

**Cheryl Cross**¹, Matthew Pawley¹, Karen Stockin¹

¹Massey University, Auckland, New Zealand

Appropriate cetacean management is critical to successful conservation efforts and particularly important for endangered and endemic species. However, managers face challenges, such as rising anthropogenic influences and deficiencies in pertinent data. Amidst human development, in Queen Charlotte Sound (QCS), New Zealand, endangered and endemic Hector’s dolphins (*Cephalorhynchus hectori hectori*) and nationally endangered bottlenose dolphins (*Tursiops truncatus*) co-exist. This study aimed to compare the spatiotemporal trends of these two sympatric delphinid species, to explore management options that would support the continued survival of both species. Dolphin geospatial sighting data
were collected year-round aboard opportunistic vessels, from 2011-2014. A total of 1,613 hours of on effort survey coverage within 263.6 km² was achieved, resulting in the observation of 290 and 268 independent groups of Hector’s and bottlenose dolphins, respectively. Interspecific temporal trends were examined using counts of dolphin groups and individuals, per hour of search effort. To assess spatial patterns, kernel density estimates (KDE) were calculated per species, based on sightings standardized by the total hours of survey effort within 3x3 km grid cells. From these KDE rasters, 95% and 50% isopleths were generated, to delineate dolphin range and central range, respectively, within QCS and to examine species spatial overlap. Hector’s dolphins exhibited temporal peaks during summer and displayed a restricted central (10.6 km²) and overall range (58.8 km²), with broader seasonal distribution during summer and autumn. Comparatively, bottlenose dolphins demonstrated more widespread use of QCS, with a central range of 65.2 km² and overall range of 187.1 km². Spatial overlap occurred in the mid to outer sector of QCS. Interspecific spatiotemporal trends suggest that each species has different ecological needs. Species-specific guidelines may be required if area-based management options are to effectively conserve these ecologically distinct species, even within a rather modest spatial management region such as QCS.

**Shiny tools for management rules: using R and 'shiny' to inform dynamic management of North Atlantic right whales (Eubalaena glacialis)**

Leah Crowe¹, Hansen Johnson²

¹Integrated Statistics / Northeast Fisheries Science Center, ²Dalhousie University

Effective dynamic management for endangered species requires the ability to respond to detections by quickly implementing conservation measures. In the United States and Canada, several dynamic management strategies reactive to both visual and acoustic detections are used to mitigate threats from shipping and fishing activities to aid in the recovery of the critically endangered North Atlantic right whale (*Eubalaena glacialis*). In the last decade, right whale distribution and observed occupancy shifts have sparked renewed attention to dynamic management measures as whales and mortality events have often been detected outside of seasonal protection areas. The implementation of protection measures requires the rapid application of various calculations to near real-time detection information collated from a variety of monitoring organizations and platforms. To streamline the process of turning right whale detections into management actions in a reproducible and publicly available way, several tools have been developed in the R programming language that rely upon the 'shiny' package for interactive, web-based data visualization. Here we describe two separate suites of 'shiny' applications developed by right whale researchers that are currently used in the process of determining dynamic right whale protection zones. Features of these tools include summarizing survey detections and effort from different monitoring platforms (e.g., ocean gliders and moored buoys with acoustic sensors, aerial and shipboard surveys with visual observers) to share with managers and other stakeholders, calculations of recommended dynamic management zones (e.g., SLOW zones in the Northeast and mid-Atlantic regions of the United States) based on visual and acoustic detections, and interactive maps to visual effort and detection data. We aim to demonstrate how effective applications can be developed by researchers without formal computer science training using accessible, open source tools (R and RStudio) to minimize the time between detections and the implementation of management rules.
Marine mammal density and movement estimation: A spatial capture-recapture analysis of North Atlantic right whale aerial survey data  
Nathan Crum1, Timothy Gowan2, Lisa Neyman3  
1Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, St. Petersburg, Florida, 2Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, St Petersburg, Florida, 3Florida Fish and Wildlife Conservation Commission  

Marine mammal population density is often estimated by distance sampling analyses of line transect surveys. A common challenge of these analyses is estimating the availability of marine mammals for detection. Estimating availability often requires a separate study, and if availability is not accounted for density can be underestimated. Alternatively, search encounter spatial capture-recapture (SCR) can estimate density and availability from line transect data when individuals in the population of interest are identifiable. SCR can also estimate demographic rates and individual space use. Most applications of SCR assume that an individual’s space use is distributed about a fixed home range center, which may not be valid for many marine mammal species. We developed a formulation of SCR that models Markovian movement of individuals without fixed home range centers and should be more appropriate for marine mammal applications. Our formulation also models detection probability in the same manner as distance sampling, where detection probability is a function of an individual’s distance to the closest point on a transect line. We estimate spatial patterns of density, space use, and demographic rates of North Atlantic right whales in the Southeastern United States from aerial line transect surveys and photo identification data using our SCR model. North Atlantic right whales had peak density in areas with sea surface temperatures between 12°C and 18°C, with depths between 10m and 25m, and with low wind speeds. We demonstrate how line transect surveys, individual identification data, and spatially explicit habitat data can be integrated to simultaneously estimate density, movement, and demographic rates of a wide-ranging marine mammal species.

Environmental effects on the abundance and trophic breadth of California sea lions from Los Islotes (Bahía de La Paz, Mexico) and its relationship with pup body condition  
Romyna Arysbeth Cruz Vallejo1, Fernando R. Elorriaga-Verplancken2, Hiram Rosales2, Rodrigo Moncayo-Estrada2, Jaime Gomez-Gutierrez2, Rogelio Gonzalez-Armas2, Claudia Hernandez Camacho3  
1Centro Interdisciplinario de Ciencias Marinas, Mexico, 2La Paz, Baja California Sur, Mexico, 3CICIMAR-IPN, La Paz, Mexico  

The California sea lion (Zalophus californianus) population in the Gulf of California has decreased around 65% between 1991 and 2019, related to the long-term sea surface warming that has had an impact on trophic dynamics. However, the breeding colony at Los Islotes (southwest Gulf of California) is the only rookery that has not shown this decrement. The goal of this study was to estimate the abundance and trophic breadth of this colony and its relationship with the sea surface temperature (SST) around the study area between 2013-2018. Monthly colony counts were performed and analyses of stable isotopes of nitrogen (δ15N) and carbon (δ13C) were done on the fur of 148 pups (isotopic maternal proxies) to obtain interannual isotopic areas of their mothers. Analyzed pups were previously weighed. By considering all age classes, abundance was similar among breeding seasons (summer; 400-506 individuals). However, a 50-60% decrease in pup abundance was documented in 2014 and 2015, compared to 2013, likely associated with warm SST anomalies recorded in the region that probably impacted prey availability and, consequently, female fecundity. There was a significant inverse

159
correlation \( (p=0.0384) \) between average pup weight and SST anomalies, showing that this variable was affected by around 3.5 kg during the warming of 2014 and 2018. Adult females showed inter-annual differences in their isotopic areas \((0.90-3.18\%^\circ)\), as a probable consequence of different dispersal degrees during their feeding trips, as a sign of variation during anomalous warm conditions. Our findings evidence the effects of SST anomalies on the sea lions from Los Islotes, as well as their adjustment capability, highlighting the need of long-term surveys in this region of the Gulf of California.

Retrospective study of osteopathological findings in cetaceans stranded off Ceará state, Brazil (1993-2012)

Mayra Csapoi, Josué Díaz-Delgado2, José Luiz Catao-Dias3, Kátia R. Groch4, Vitor Luz Carvalho1

1São Paulo University - USP, São Paulo, São Paulo, Brazil, 2Atlantic Cetacean Research Center, Institute of Animal Health, University of Las Palmas de Gran Canaria, Spain, Arucas, Spain, 3School of Veterinary Medicine and Animal Science, University of São Paulo, São Paulo, Brazil, 4Universidade de São Paulo, São Paulo, 5Associação de Pesquisa e Preservação de Ecossistemas Aquáticos, Fortaleza, Ceará, Brazil

Osteopathological examinations may be key to understand the cause(s) of strandings and death in cetaceans. Often, skeletal disease processes are not readily evident during field autopsies as diagnostic imaging techniques are generally not accessible and field conditions may preclude detailed analysis. Therefore, most osteopathological knowledge in cetaceans has stemmed from post-mortem examination of archival specimens. We investigated retrospectively the pathological findings of complete or partial axial skeletons of 38 odontocetes, representing seven species *Sotalia guianensis* (n=14), *Stenella clymene* (n=8), *S. longirostris* (n=5), *S. frontalis* (n=4), *Peponocephala electra* (n=3), *Globicephala macrorhynchus* (n=3), and *S. coeruleoalba* (n=1), that stranded off Ceará state, Brazil, between 1993 and 2012. Sex distribution was female (n=9), male (n=14), and non-determined (ND; n=15); age distribution was calf (n=4), juvenile (n=13), adult (n=19), and ND (n=2). Current nomenclature was followed; lesions were grouped into comprehensive categories, namely congenital/developmental, inflammatory/infectious, degenerative, and traumatic processes. Preliminary results revealed a variety of lesions; concomitant lesions of varying origins in a single animal were common. Osteopathological findings were detected in 34/38 (89%) dolphins. Animals with lesions were 32% males, 26% females and 41% ND. Adults and juveniles exhibited higher lesion occurrence, 53% and 35%, respectively. Congenital/developmental malformations prevailed (21/38, 55%), primarily represented by unfused neural arches in cervical vertebrae. Degenerative lesions were observed in 18/38 (47%) animals, more frequently in thoracic vertebrae. Traumatic injuries were found in 16/38 (42%) animals and were more common in ribs, followed by lumbar vertebral processes. Inflammatory/infectious processes were observed in 15/38 (39%) animals, mostly involving nematodal pterygoid fossae and/or periotic osteomyelitis and osteolysis, followed by discospondylitis/spondylitis. Two *P. electra* stranded alive exhibited severe post-exertional (capture myopathy) spinous processes axial deviation. These results contribute to baseline osteopathy knowledge of cetaceans stranded in Brazil and may be of value for comparative pathology and monitoring purposes.

Walrus from Space: Getting the crowd involved

Hannah Cubaynes1, Peter Fretwell2, Rod Downie3

1British Antarctic Survey, 2British Antarctic
As sea ice retreats in the Arctic, the future of walrus (*Odobenus rosmarus*) is uncertain. Understanding how the alteration in their habitat is affecting them is essential to predict and safeguard their existence. Walrus monitoring needs to be at the pan-Arctic scale to reflect their wide distribution, and preferably annual to match the rapid changes in sea ice conditions. However, it is logistically challenging to access a region as vast and remote as the Arctic via boats or planes, limiting the areas where field surveys can be conducted, as well as restricting the regularity of such surveys. Satellite images could be a non-invasive solution to studying walrus across the Arctic annually, as well as helping to survey in times when it is challenging to conduct field research such as during the Covid-19 pandemic. Walrus have previously been successfully detected on satellite images of 50cm resolution over a few Russian haul-outs. We are proposing to expand this to all walrus terrestrial haul-outs, with an initial testing for the Atlantic and Laptev Sea haul-outs. As scanning images of the whole Arctic in search of walrus can be a long process if one person is reviewing the images, we are asking the crowd to help us detect walrus in approximately 600,000 satellite image chips covering about 24,000km².

**Common bottlenose dolphin (Tursiops truncatus) habitat utilization in a complex, estuarine environment**

Anna Cummings-Krueger¹, Tara Cox², Robin Perrtree²
¹Savannah State University, Savannah, GA, ²Savannah State University, Savannah, Georgia

Habitat utilization is a key component to understanding the fundamental ecology of a species. The complex, estuarine system along the southeastern United States has extensive tidal creeks, which provide common bottlenose dolphins (*Tursiops truncatus*) with unique opportunities to interact with the surrounding environment. In less complex study areas, various parameters that influence habitat use have been identified, including depth, temperature, and salinity. This study will investigate the correlates of space, depth, salinity, temperature, creek width, and tidal state on common bottlenose dolphins in a complex, estuarine system. The study area encompasses approximately 340 km² of estuarine habitat south of the Savannah River and north of Ossabaw Sound near Savannah, Georgia, USA. Photo-identification surveys have been conducted along transects since 2009, during which parameters were measured in the field or in ArcMap 10.7. Spatial analyses will be conducted to identify which environmental parameters could be influencing dolphin distribution. Based on preliminary analyses, dolphins in small group sizes of less than 5 individuals (n=1534) are primarily found as the tide is ebbing, in a mean water temperature of 24.2 ± 6.9 °C, a mean salinity of 26.9 ± 5.8 ppt, a mean depth of 6.3 ± 3.4 m, and a mean creek width of 592.9 ± 728.8 m. Dolphins in large group sizes of 8 or more individuals (n=383) are primarily found as the tide is ebning, in a mean water temperature of 27.3 ± 4.5 °C, a mean salinity of 27.5 ± 5.7 ppt, a mean depth of 6.2 ± 2.8 m, and a mean creek width of 880.7 ± 1016.3 m. Creek width is highly variable in this complex, estuarine system; therefore, creek connectivity may be more informative of habitat utilization in the southeast USA.

**Rapid weight loss in free ranging pygmy killer whales: implications for anthropogenic disturbance of odontocetes**

Jens Currie¹, Martin van Aswegen², Stephanie Stack¹, Kristi West³, Fabien Vivier¹, Lars Bejder⁵
¹Pacific Whale Foundation, ²Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Honolulu, Hawaii, ³University of Hawaii,
Understanding the impacts of foraging disruptions to odontocete body condition is fundamental to quantifying the biological effects of human disturbance and environmental changes on cetacean populations. Odontocetes have high metabolic rates, and as a result, individuals spend a considerable amount of time and energy on pursuing and capturing prey. As such, even short disruptions can have the potential for immediate impact through reductions of foraging success. Here, reductions in body volume of free-ranging pygmy killer whales (*Feresa attenuata*) were calculated using repeated measurements of the same individuals obtained through Unoccupied Aerial System (UAS)-photogrammetry during a prolonged disruption in foraging activity arising from a 21-day stranding event. In addition to repeat measurements of body volume, stranded individuals were used to confirm abnormal foraging as well as verify UAS-derived volume and length estimates through 3D-imaging, water displacement, and post-mortem measurements. We show that UAS estimates of length were within 1.5% of actual body length and UAS volume estimates were within 10-13% of actual volume. Over the 21 day foraging disruption, the mean daily body volume losses for individuals ranged from 0.8-2.6% of total body volume. In total, we documented losses in body volumes ranging from 0.02-0.04 m³, which is equal to approximately 20.6-45.3 kg/individual, or in some cases 27% of the animal's total body weight. Both adipocyte and body mass index values were calculated and indicated low energy reserves, suggesting they could serve as indicators of poor body condition. The findings presented here highlight the use of UAS as a promising method to remotely monitor changes in body condition and health of odontocetes. Numerous coastal populations of odontocetes are experiencing disruptions to natural behavioral patterns arising from various anthropogenic activities. The potential effects this has on free-ranging odontocetes can be effectively quantified using UAS.

**Gulf of Mexico Dolphin Identification System (GoMDIS)- A collaborative effort to better define bottlenose dolphin movements**

Carolyn Cush¹, Randall Wells², Jeff Adams³, Ei Fujioka⁴, Kim Urian⁵

¹Chicago Zoological Society’s Sarasota Dolphin Research Program, San Diego, ²Chicago Zoological Society’s Sarasota Dolphin Research Program, Sarasota, Florida, ³NOAA, Fisheries, Silver Spring, Maryland, ⁴Duke University Marine Geospatial Ecology Lab, Durham, ⁵Duke University Marine Lab, Beaufort, North Carolina

The 2010 Deepwater Horizon oil spill and Unusual Mortality Events in the northern Gulf of Mexico, demonstrated the need for additional information on bottlenose dolphin movements and ranges. No mechanism existed for detecting and monitoring range shifts in response to these events, or for readily identifying the origins of stranded dolphins. To address this issue, a collaboration was formed in 2012, involving federal and state agencies, non-profits, and academia with NMFS-permitted photographic-identification projects, as well as stranding programs and international partners. The Gulf of Mexico Dolphin Identification System (GoMDIS) provides a venue to house dolphin identification data from collaborating research groups Gulf-wide, including Cuba and Mexico. The objectives are to: 1) maintain a collaborative compilation of dolphin identification data, 2) build and maintain a repository for identification images and 3) facilitate data sharing among colleagues to examine dolphin movements through the Gulf. The Chicago Zoological Society’s Sarasota Dolphin Research Program (SDRP) curates GoMDIS. Data are provided by
our contributors and stored both offline on our secure server at SDRP, and on Duke University’s OBIS-SEAMAP, which is accessible via an online portal, allowing collaborators to browse regional catalogs of interest, and go through animal matching workflow. Access to the OBIS-SEAMAP portal allows the contributors to download match lists and contact others for additional animal sighting data. GoMDIS is constantly updating, currently including 40 catalogs, 24,524 animals and 44,013 images, yielding 1,961 matches between projects (current and archived) to date. We expect GoMDIS to grow and evolve as a long-term conservation decision-making tool. To ensure continuing success, it will be necessary to 1) establish ongoing, long-term funding for operations, 2) find new photo-ID research, 3) receive and process catalogs with improved data processing framework, 4) incorporate automated fin matching within the OBIS-SEAMAP portal, and 5) maintain communication between the curator and collaborators.

Impacts of Tropical Storm Debby and Hurricane Irma on common bottlenose dolphins (Tursiops truncatus) sound production in the Gulf of Mexico and Tampa Bay
Kelly Cusick1, Shannon Gowans2, David Mann1, Peter Simard4
1Eckerd College, Saint Petersburg, FL, 2Eckerd College, St Petersburg, FL, 3Loggerhead Instruments, Inc., Sarasota, FL, 4Eckerd College, St. Petersburg, FL

Tropical cyclones can have acute physical and biological effects on coastal and marine ecosystems. Several studies have investigated the effects of storms on lower trophic levels (e.g., seagrass, fishes, corals), but the effects on top predators such as cetaceans are largely unknown. Most studies examine the effects of these storms through traditional boat-based survey methods, which are not possible during the passage of tropical cyclones. In this study, Digital SpectroGram (DSG) autonomous acoustic recorders deployed in Tampa Bay and the Gulf of Mexico were used to detect common bottlenose dolphin (Tursiops truncatus) sounds during two tropical cyclones that affected the area: Tropical Storm Debby (June 2012) and Hurricane Irma (September 2017). Both storms brought considerable impacts to the study area, such as sea level anomalies, high rainfall, and high winds. Dolphin sounds (whistles, echolocation trains, burst pulses, and low frequency narrow-band sounds) were identified manually in 1024-point spectrograms (Raven Pro 1.5, Cornell University). Dolphin detection rates (detections/hour/km²) were determined for each sound type for each station for 15 day periods centered on the peak storm conditions using an algorithm to calculate the active space of detection corrected for ambient noise levels. A generalized linear model was used to analyze detection rates in relation to sea level anomaly, water temperature, wind speed, barometric pressure, and fish acoustic activity. Preliminary results showed a simultaneous decrease in dolphin sound production rates at all three stations during Tropical Storm Debby, with significant relationships between sound production rates and several storm variables (e.g., wind speed, storm surge). As the frequency and intensity of tropical cyclones is expected to increase due to climate change, it is crucial to determine the ecological effects of these storms, including the resistance and resilience of top predators such as bottlenose dolphins.

Applying Regulatory Processes to Support Marine Mammal Conservation: A Case Study - Mid-Barataria Sediment Diversion
Jaclyn Daly1, Teresa Rowles1, Mel Landry1, Lance Garrison1, Erin Fougeres1, LAURA ENGLEBY6, Jenny Litz2, Holly Wheeler4
1NOAA NMFS, Ellicott City, 2Silver Spring, Maryland, 3NOAA Restoration Center, Baton Rouge, LA, 4Miami, FL, 5NOAA Fisheries
Southeast Regional Office, St. Petersburg, FL, 6NOAA NMFS Southeast Region, 7Marine Mammal and Turtle Division, SEFSC, NOAA Fisheries, Miami, Florida, 8National Oceanic and Atmospheric Administration, Silver Spring, Maryland

The proposed Mid-Barataria Sediment Diversion (MBSD) is an unparalleled, large-scale project that would reconnect the Mississippi River to Barataria Bay in Louisiana, an ecosystem heavily impacted by the 2010 Deepwater Horizon (DWH) oil spill. The MBSD is designed to mimic the natural processes that built and sustained coastal Louisiana before the river was leveed and managed for navigation and flood protection. Introducing riverine waters would shift salinity regimes, freshening Barataria Bay. Consequently, resident bottlenose dolphins inhabiting the bay would be exposed to extended periods of low salinity, resulting in morbidity and reduced survival. These dolphins were exposed to DWH oil and continue to suffer impacts even a decade after the spill. As part of the Louisiana Trustee Implementation Group, NOAA has navigated complex regulatory and scientific challenges associated with this project. Through the evaluation of the project in the Draft Environmental Impact Statement (DEIS) and Natural Resource Damage Assessment Draft Restoration Plan (RP), we have achieved an in-depth, multi-faceted scientific understanding of complex issues associated with MBSD operation. As described in the DEIS, mean dolphin population survival rate would decline by 34% (95% confidence interval: 15.3%-62.7%) in any given average flow year and the greatest impacts would be on dolphins inhabiting the central and western portions of the bay. Through NOAA’s multiple roles in the project, we developed a marine mammal monitoring and adaptive management plan for Barataria Bay dolphins and identified a suite of stewardship measures for bottlenose dolphins state-wide. Moreover, through our analysis, we have improved the scientific understanding of the impacts of low salinity exposure to inform a multitude of management decisions. This effort can serve as an example of turning science into stewardship for other large-scale, complex projects involving novel challenges and solutions.

Which Drone Should You Buy to Study Dolphins?: The Use of Drones to Assess Dolphin Response Behavior at Various Heights With Commonly Used Platforms

Savannah Damiano1, Jason Bruck1
1Stephen F. Austin State University, Nacogdoches, Texas

As part of a larger project studying the effects of human activity on bottlenose dolphin populations, we used a managed-care population in Bermuda to determine how animals subjected to levels of anthropogenic stimuli react to commonly used UAV (Uncrewed Aerial Vehicle) platforms. It is hypothesized that living amongst high levels of human activity may decrease dolphin responses to UAVs through generalized habituation. Dolphin Quest Bermuda’s eleven bottlenose dolphins were used as a control group to determine how wild animals in industrialized areas with high levels of anthropogenic noise may respond to commonly used drones. The information gathered from the managed population will be used to compare attention and aversion responses to various UAV types and drone heights in wild groups. The dolphins were evaluated for responses to three drone types, the DJI Mini 2, the DJI Mavic 2 Enterprise Advanced, and the DJI Inspire 2. At each height for each drone type, individual dolphin responses were evaluated for number of looks, duration of looks, and the amount of time submerged underwater.

Tactile Exchanges, While Accounting for Group Composition, Between Atlantic Spotted Dolphins Around Bimini, The Bahamas

Nicole Danaher-Garcia1, Richard Connor2, Gavin Fay3, Kelly Melillo-Sweeting4, Kathleen
Social systems are characterized by the pattern of sex-specific relationships that are themselves determined by patterns of interactions between individuals over time. Long-term behavioral studies offer the opportunity to investigate affiliative interaction (e.g., tactile exchanges) between individuals. A population of Atlantic spotted dolphins (*Stenella frontalis*) off Bimini, The Bahamas, is known to exhibit non-random associations with a preference for same-sex associates of similar age. A 16-year archive (2003 – 2018) of systematically collected underwater video of these dolphins was used to document all body contact (n = 1,447) between individuals. Patterns of interaction relating to age and sex of the initiating and receiving dolphins were investigated in R while controlling for partner availability based on group composition during observations. We controlled for partner availability during observations by weighting the probability of a tactile exchange based on the number of individuals of each age class and sex in a given group. Dolphins exchanged the most contact with others of similar age and same sex, and juvenile dolphins initiated the most contact of any age class. This study expands upon previous pectoral fin contact studies by presenting the first comprehensive investigation of tactile exchanges for a dolphin population while taking group composition into account.

**Temporal variation in the feeding habits of female Southern elephant seals, *Mirounga leonina*, at Isla 25 de mayo/ King George Island, South Shetland Islands, Antarctica.**

Gustavo A. Daneri¹, Enrique Alberto Marschoff⁵, Ana Harrington¹, Javier Negrete⁴, Mariana Descalzo⁴

¹Museo Argentino de Ciencias Naturales Bernardino Rivadavia - CONICET, Lomas de Zamora, Buenos Aires, Argentina, ²Instituto Antártico Argentino, General San Martín, Buenos Aires, Argentina, ³Instituto de Investigaciones en Producción Animal (INPA), CONICET-UBA, CABA, Buenos Aires, Argentina, ⁴Buenos Aires, Argentina, ⁵Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Florida, Buenos Aires, Argentina

The Southern elephant seal, *Mirounga leonina*, is an important apex predator that is widely distributed in the Southern Ocean, their main breeding concentrations located on subantarctic Islands. Food availability in the ocean has been suggested as a proximate cause in changes in the population numbers of different Southern elephant seal colonies. The aim of this study was to examine the feeding habits of the female component of the Isla 25 de mayo/King George Island elephant seals colony, throughout 8 consecutive years (late spring/summer 1995/6 - 2002/3) coinciding with the beginning of the moulting period. Mature female seals (N=99) which had recently arrived ashore were anaesthetised and then subjected to stomach lavage. The diluted stomach contents were sieved (1.0 mm mesh) and the different prey taxa sorted. For the total period of study the cephalopod diet was dominated by the Antarctic glacial squid, *Psychroteuthis glacialis*, which occurred in almost 90% of stomach samples and constituted alone 57% in numbers and 64% in mass of cephalopods ingested. Other teuthoid species of relevance were *Slozarsykovia circumantarctica* and *Alluroteuthis antarcticus* in terms of occurrence and numbers and *Moroteuthopsis longimana* in terms of mass. Fish were mainly represented by the myctophid *Gymnoscopelus nicholsi* which occurred in over 90% of samples, constituting almost 80% in numbers and mass of all identified fish. The
nototheniid *Pleuragramma antarctica* was second in importance though in much lower proportions. Temporal variation in cephalopod predation by seals showed a uniform dominance of *P. glacialis*, but with a notable decrease in its contribution to the diet between the 1997/8 and 1999/2000 seasons. This could be related to changes in oceanographic conditions and marine communities structure of the Southern Ocean derived from one of the most severe El Niño Southern Oscillation events in 1997/98.

**Comparison of Different Fixation and Staining Techniques on the Morphometric Assessment of Florida Manatee Spermatozoa**

*Sofia Danford*¹, Jonathan Cowart², Danielle Collins³, Iskande Larkin⁴

¹Aquatic Animal Health Program, College of Veterinary Medicine, University of Florida, ²University of Florida, ³Department of Animal Sciences, College of Agricultural and Life Sciences, University of Florida, Gainesville, Florida, ⁴University of Florida, Gainesville, Florida

In males, characteristics such as sperm morphology and morphometry, in conjunction with other measures of sperm quality, are important indicators of fertility. Currently, the industry standard for sperm morphometry analysis is computer-aided sperm morphometry analysis (CASMA). In order to best utilize CASMA for morphometric analysis of sperm, species-specific sperm fixation and staining protocols must be established. Such protocols have yet to be developed for most marine marine mammal species, including the Florida manatee (*Trichechus manatus latirostris*). Therefore, the objective of this study was to compare the influence of fixation and staining techniques on Florida manatee sperm morphometry. Sperm were retrieved postmortem from the vas deferens of five recently deceased Florida manatees. Samples were fixed with one of three fixatives: buffered formal saline (BFS), 2.5% glutaraldehyde in 0.1M sodium cacodylate buffer, or 4% paraformaldehyde. Samples were subsequently stained with one of four stains: SpermBlue®, Coomassie blue, Hemacolor™, or Quick III™. 200 sperm per sample were randomly analyzed for each fixative/stain combination via CASMA. Analyzed sperm head morphometric parameters included: length, width, perimeter, area, ellipticity, elongation, regularity, and roughness. Both staining and fixation had significant effects on the morphometry of the sperm head. For measures of sperm head size (*i.e.* length, width, area, and perimeter), sperm stained with Coomassie blue and SpermBlue® were significantly larger compared to Hemacolor™ and Quick III™, and there were no significant differences between sperm stained with Hemacolor™ versus Quick III™. Fixation affected all parameters, except for ellipticity and elongation, with the majority of the differences seen between glutaraldehyde and BFS. The results of this study contribute to a larger objective of establishing standardized protocols for sample collection, processing, fixation, staining, and morphometric analysis of Florida manatee spermatozoa. This study highlights the influences of fixation and staining protocols on sperm morphometry as well as the importance of creating standardized protocols for this species.

**Preliminary Analysis of Sperm Morphology and Morphometry in Atlantic Spotted Dolphins (Stenella frontalis)**

*Katie Dantoni*¹, Jonathan Cowart², Iskande Larkin³

¹Aquatic Animal Health Program, University of Florida College of Veterinary Medicine, ²University of Florida, ³University of Florida, Gainesville, Florida

Cetacean reproductive biology is not well documented across taxa, particularly as it relates to sperm morphology, morphometry, and structure. Study of these characteristics yields
essential information on the functional composition of sperm as well as insight into the reproductive physiology of a species. This is especially important in endangered species, such as cetaceans, where information regarding the spermatozoon is scant for most species. In this study, computer-aided sperm morphology analysis (CASMA) was used to analyze the morphometry and morphology of sperm retrieved postmortem from the vas deferens of two recently deceased Atlantic spotted dolphins (*Stenella frontalis*). 250 sperm per sample were randomly analyzed for 13 different morphometric parameters: head length (µ = 5.27 ± 0.21 µm), head width (µ = 2.45 ± 0.12 µm), head area (µ = 11.05 ± 1.10 µm²), head perimeter (µ = 11.26 ± 0.54 µm), head ellipticity (µ = 2.16 ± 0.12), head elongation (µ = 0.37 ± 0.03), head roughness (µ = 0.92 ± 0.07), head regularity (µ = 0.73 ± 0.13 µm), head piece length (µ = 62.83 ± 1.42 µm), midpiece length (µ = 65.36 ± 1.43 µm), flagellum length (µ = 71.25 ± 1.46 µm), and total length (µ = 71.25 ± 1.46 µm).

Morphologically, the spermatozoon had a small, oval-shaped head, accounting for 7.24% of total sperm length. The connecting piece was distinguishable between the head and midpiece, accounting for 1.02% of total sperm length. The midpiece was short in length, accounting for 3.55% of total sperm length, and contained a small number of largely-sized mitochondria. The principal piece + end piece was the largest component, accounting for 88.19% of total sperm length. This study provides unique preliminary observations into the morphology of Atlantic spotted dolphin sperm, which has not been previously described. Further study will yield additional understanding of the relationship between form and function, particularly in an evolutionary context.

**From museum to field and necropsy sampling:** a long history of seals and porpoises in the North Sea

*Krishna Das¹, France Damseaux¹, Paddy Pomeroy², Thierry Jauniaux¹, Marianna Pinzone⁴, Gilles Lepoint¹, Anita Gilles³, Ursula Siebert⁶
¹University of Liege, Liège, Belgium, ²Sea Mammal Research Unit, St Andrews, United Kingdom, ³University of Liege, Liège, Belgium, ⁴Ixelles, Belgium, ⁵ITAW - University of Veterinary Medicine Hannover Foundation, Büsum, Schleswig-Holstein, Germany, ⁶Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Büsum, Schleswig-Holstein, Germany*

The average temperature of the North Sea has risen twice as fast as the oceans of the world with already detectable consequences to the ecosystem. The North Sea is a critical habitat to different marine mammal species including the grey seal, *Halichoerus grypus*, the harbour seal *Phoca vitulina*, and the harbour porpoise, *Phocoena phocoena*. Long-term approach of their feeding ecology is crucially needed to understand their response in term of global changes and management of their population. A multi-tracer approach ([THg] and [Se]; d¹³C, d¹⁵N, d³⁴S values) was applied on harbour seals and grey seals (blood; German and Scottish coasts, n=174 and n=80, respectively) during different time periods (from 1900 to 2017). Additionally, the same tracers were analysed in harbour seals (hair; from 1930 to 2017) from the Natural History Museum of Stockholm (n =10), free-ranging and stranded harbour seals from the North Sea (German and Belgian coasts, n=40 and n=6, respectively). Data acquired previously on harbour porpoises from the southern part of the North Sea were integrated (muscle; 1994-2018, n=188). Our multi-tracer approach revealed:

1. an increase of trophic niche size and foraging distribution (from inshore to offshore), an increase of foraging resource items (more flatfish and less sandeels) for Scottish grey seals over time;
2. long-term changes having affected the North Sea are reflected in hair collected from harbour
Seals. We found a linear concomitant increase of [THg] and d13C values, reflecting a higher exposure combined to a more intense use of wind farm locations for foraging activities. Wind farms areas are particular ecosystems with an abundant marine life and different isotopic values.

To conclude, our results showed a high degree of plasticity in foraging resources for harbour seals and in foraging spatial distribution for grey seals. More research is needed to infer on impacts of wind farms, also in relation to disturbance.

**A Picture is Worth a Thousand Whales? Modeling French Polynesia Humpback Whale Abundance Using RMark**

Savannah Daughtry1, Renee Albertson2, M. Michael Poole2, Marc Oremus3, John McClung3

1Oregon State University, 2Department of Fisheries and Wildlife Sciences, Oregon State University, Newport, Oregon, 3Marine Mammal Research Program, Moorea, French Polynesia, 4World Wildlife Fund, France, Noumea, New Caledonia, France, 5The Cook Inlet Beluga Whale Photo-ID Project, Anchorage, Alaska

Extensive whaling in the twentieth century resulted in the taking of over 200,000 humpback whales (*Megaptera novaeangliae*) in the Southern Hemisphere. As a result, humpback whale populations in remote French Polynesia and other South Pacific breeding grounds are still listed as “Endangered” as they continue to recover. To aid in the continued monitoring of their recovery, we evaluated abundance and survival using capture-recapture history spanning 21 years across four archipelagos in French Polynesia breeding grounds. Humpback whales were observed within the Society, Austral, Gambier, and Tuamotu Archipelagos. Using photo-identification of the ventral aspect of the flukes, we made a total of n=607 sightings for the years 1990-2010 and 2013, of which n=94 were resighted unique individuals. Opportunistic sampling resulted in higher sampling effort in the Society Islands which accounted for nearly 86% of individuals. Whales were resighted anywhere between two (n=59) and five (n=1) times during the study period. Two individuals were resighted in a different archipelago than their original sightings. Two models were fit with Program MARK using the RMark interface. Abundance was estimated using the open models CJS with random effects, which takes into account variability of sampling effort, and POPAN, which calculates a super population consisting of variations of survival, point of entry, and capture probability. CJS resulted in a yearly estimated range of 763-3,199 individuals with a survival of 0.886 (95% CI=0.801-0.937). POPAN resulted in $N_{super}=3,193$ (95% CI=2597-3968) individuals. These estimates are the first of their kind to encompass over twenty years of humpback whale sighting data in French Polynesia and will act as a critical reference point for monitoring this population’s recovery.

**Case study: Stomach content analysis of stranded bottlenose dolphins (Tursiops truncatus) during a red tide bloom in southwest Florida**

Emily Davidson1, Hada Herring, Jill Richardson2, Denise Boyd3, Molly Schubert, Megan Krzewinski4, Evan D’Alessandro5

1Florida Fish and Wildlife Conservation Commission, PORT CHARLOTTE, Florida, 2University of Miami, Rosental School of Marine and Atmospheric Science, Miami, Florida, 3Florida Fish and Wildlife Conservation Commission, Port Charlotte, FL, 4Lowcountry Marine Mammal Network, Summerville, SC, 5University of Miami, RSMAS, Miami, Florida

Stomach content analyses of expired, stranded marine mammals have provided valuable information regarding the diet of many species. An understanding of diet is essential to assess habitat use, quality, energetics, and nutrient requirements relevant to various life stages.
Cetacean stomach content studies enhance conservation efforts by identifying high value habitats and documenting how species respond to changes in prey availability. These studies are especially important to monitor dietary shifts during times of trophic cascade alteration (e.g., harmful algal blooms). Beginning November 2017, the west coast of Florida experienced a harmful algal bloom (HAB) of *Karenia brevis*. The brevetoxin produced by this HAB was determined to be the cause of a cetacean unusual mortality event (UME), which occurred from July 1, 2018, through June 30, 2019. During this UME, stomach contents of forty-six bottlenose dolphins (*Tursiops truncatus*) that stranded in southwest Florida were collected at necropsy and frozen for future analysis. Based solely on gross observations of partially digested prey items, remains of common prey species were noted, including members of the families Sparidae, Clupeidae, and Sciaenidae. However, a novel finding in stomach contents during this HAB event were members of the family Ophichthidae (snake eels). Preliminary analyses of the forty-six stomach content samples revealed that eight contained partially digested snake eel remains, including skulls and jaw bones. Challenges with otolith identification were encountered during analysis of stomach contents and led to the currently ongoing development of a physical otolith reference collection for prey species in southwest Florida. Finalizing the reference collection through collaboration and continued stomach content analyses will facilitate open access to this resource for current and future efforts and serve to further our understanding of bottlenose dolphin diet, vectors for brevetoxin, and shifts in diet related to prey availability in an area regularly affected by HABs.

Identifying factors that influence animal population density can provide insight into why it varies spatially and temporally and when a recovering population has reached an equilibrium density because of food resources (i.e., carrying capacity *K*). Although food availability is widely recognized as an important extrinsic factor (i.e., limiting resource) affecting sea otter (*Enhydra lutris*) population density, how do we determine when it has reached *K*? The goal of this study was to estimate *K* for Simpson Bay, Alaska by measuring the abundance of bivalves, the primary prey for sea otters for over 40 years. We then compared prey abundance and estimated replacement rate to estimated annual prey consumption based on the mean population density for the past 18 years. On average, 110 adult sea otters (5.2 km⁻²) have occupied Simpson Bay annually since 2001 consuming an estimated 176,660 kg of bivalves. The total biomass (i.e., standing stock) of the major bivalves was 785,730 kg, so adult sea otters consumed ~22% of this biomass annually. Based on these observations and calculations, the estimated annual number of sea otters occupying Simpson Bay appears to be at or near *K* based on 1) a stable population density and 2) the estimated replacement rate of food resources. Understanding factors that limit population size may be one of the most challenging questions in conservation biology. The approach used herein, which examines limits to sea otter populations as they recover from exploitation in the 18th and 19th centuries, may be broadly applicable to other recovering species.
Anchored tags are being used with increasing frequency to study the movement, behavior and population structure of cetaceans, but there have been few studies on the long-term fate of such devices. We examined Low Impact Minimally Percutaneous External Electronics Transmitting (LIMPET) tags deployed on short-finned pilot whales (Globicephala macrorhynchus) off Cape Hatteras, North Carolina, USA. We deployed LIMPET tags on or near the dorsal fins of 79 short-finned pilot whales from 2014 through 2019 and monitored the movements of these animals for periods up to 349 days. During this period, we deployed four distinct versions of LIMPET tags (SPOT5, SPOT6, SPLASH10, SPLASH10-F). We found a significant effect of tag placement on transmission duration (ANOVA p=0.04), with the longest transmissions obtained from tags deployed near the center of the dorsal fin. Neither dorsal fin area nor deployment distance affected transmission duration. We obtained high-resolution photographs of eight whales that had shed their tags and after more than 100 days following tag deployment. None of the eight resighted whales showed any physical damage to their dorsal fins. However, seven of the whales presented residual swelling at the tagging site, attachment hardware still present in the dorsal fin, or some combination of both. We are continuing to work with the manufacturer to improve the design and attachment hardware used with these tags to increase transmission durations and streamline the tag detachment process.

Genetic variation is essential for the health of wildlife populations and their ability to adapt to changing environments. Understanding the processes that underlie contemporary population structure and historical demographic changes can guide conservation strategies to preserve and recover at-risk populations. The northern bottlenose whale (Hyperoodon ampullatus) underwent large-scale commercial whaling, resulting in population declines which caused reductions in genetic diversity through removals and increased effects of genetic drift. Low mitochondrial diversity has been documented in this species; however, little is known about its genetic composition across the entire genome. Here we assembled the first reference genome for H. ampullatus and re-sequenced whole-genomes (n=49) from whales sampled in five regions spanning 26 degrees of latitude across the North Atlantic Ocean, providing high-resolution data to identify regional genetic patterns and evaluate geographical origins of ancestral lineages. We detected subtle population subdivision and broad patterns of increasing differentiation by distance between sampled aggregations, suggesting limitations to connectivity across the species’ range. These trends were more pronounced near the southernmost region (i.e., Scotian Shelf). We examined changes in effective population size of
each sample aggregation by reconstructing demographic history from genomic data, revealing contrasting regional patterns after the last glacial period. To investigate whether subgroups in different regions are locally adapted to unique conditions, we examined signatures of selection integrated with gene ontology analyses. Our results highlight the importance of conserving genetic diversity across multiple regions and prioritizing connectivity among them to maximize the genetic diversity available for a species to respond to demographic and environmental pressures.

A Fifteen Year Data Summary for the West Coast Marine Mammal Stranding Network
Lauren De Maio¹, Justin Greenman¹, Kristin Wilkinson², Justin Viezbicke³
¹NOAA Fisheries, Long Beach, CA, ²NOAA Fisheries, Protected Resources Division, Seattle, Washington, ³NMFS, Portland, OR, Oregon

The NOAA Fisheries’ West Coast Marine Mammal Stranding Network (WCR Network) responds to stranded pinnipeds and cetaceans along the coasts of California, Oregon, and Washington, USA. Every year there are thousands of reports of stranded marine mammals along the US West Coast. The WCR Network’s goal is to facilitate collection and dissemination of data, assess health trends in marine mammals, correlate marine mammal health with available data on physical, chemical, environmental and biological parameters and coordinate effective responses to unusual mortality events.

Data collected from marine mammal strandings by our WCR Network members are submitted for inclusion into the NOAA Fisheries’ Marine Mammal Health and Stranding Response Program (MMHSRP) National Database to establish baseline information on marine mammal communities and monitor their health. This presentation displays some of the stranding data collected by the WCR Network 2006-2020 and highlights a few regional trends. During this 15 year period, the WCR Network responded to over 60,000 stranded marine mammals, including 45,736 in California, 5,774 in Oregon, and 8,692 in Washington.

During this time, the WCR Network also dealt with eight separate unusual mortality events (UMEs), two that involved large whales, two for small cetaceans, and four for pinnipeds (two of which are visibly seen in 2009 and 2015).

Chronic Environmental Exposure of Florida manatees (Trichechus manatus latirostris) to Glyphosate: Plasma and Environmental Levels
Maite De Maria¹, Cecilia Silva-Sanchez², Kevin J. Kroll¹, Mike Walsh, Mohammad-Zaman Nouri³, Maggie Hunter¹, Monica Ross⁴, Tonya Claus⁵, Nancy Denslow⁷
¹University of Florida, GAINESVILLE, FL, ²Department of Physiological Sciences and Center for Environmental and Human Toxicology, Gainesville, Florida, ³Department of Physiological Sciences and Center for Environmental and Human Toxicology, University of Florida, Gainesville, Florida, ⁴Sirenia Project, U.S. Geological Survey, Gainesville, Florida, ⁵Clearwater Marine Aquarium Research Institute, Green Cove Springs, Florida, ⁶Georgia Aquarium, Atlanta, Georgia, ⁷Department of Physiological Sciences and Center for Environmental and Human Toxicology, University of Florida, Gainesville, Florida

Florida manatees inhabit the coastlines, internal rivers and lakes of Florida throughout the year. Florida is the northern winter boundary of the species. Rivers, lakes, canals and springs are crucial warm-water refuges when the ocean temperature drops below 20 °C. As a result, they can be exposed to run-off of agricultural and non-agricultural herbicides used in these areas. Glyphosate is the most used herbicide
worldwide, intensively used in Florida for multiple agricultural purposes including its use as a sugarcane ripener. The objective of the present study was to determine the exposure of glyphosate to Florida manatees at a warm-water refuge in Crystal River, and in South Florida in waterbodies surrounding Lake Okeechobee and its breakdown product, aminomethylphosphonic acid (AMPA). We analyzed glyphosate’s and AMPA’s concentrations in Florida manatee plasma (n=105) collected during 2009-2019 using HPLC-MS/MS. We sampled eight Florida water bodies between 2019-2020, three times a year: before, during, and after its use in sugarcane harvest using grab samples and molecular imprinted passive Polar Organic Chemical Integrative Samplers (MIP-POCIS). Glyphosate was present in 55.8% of the sampled Florida manatees’ plasma. The concentration of glyphosate has significantly increased in Florida manatee samples from 2009 until 2019. Glyphosate was present in all grab water samples and accumulated in all MIP-POCIS. Glyphosate concentration was 5 times higher in South Florida than in Crystal River, particularly before and during the sugarcane harvest. Based on these results, Florida manatees were chronically exposed to glyphosate and AMPA, during and beyond the glyphosate applications to sugarcane, possibly associated with multiple uses of glyphosate-based herbicides for other crops and to control aquatic weeds. This chronic exposure may have consequences for Florida manatees’ immune systems as has been seen in progressive studies of fish and rodents. Consequences in Florida manatee immune system are currently being analyzed with in-vitro assays.

Clapham
1Association ELI-S, Gujan-Mestras, France,
2Cascadia Research Collective, Olympia, 1Vrije Universiteit Brussel, Brussel, Belgium, 1Seastar Scientific, Vashon, Washington

Previous research has shown the presence of an endangered humpback whale population breeding off the Pacific coast of Central America. However, little is known about the density, size, social groups and spatial habitat use of this subpopulation. To fill this knowledge gap, boat-based surveys were conducted between November and April at two study sites along the Pacific coast of Nicaragua between 2004-2008 and 2016-2020. In northern Nicaragua, a total of 114 sightings including 203 individuals were observed between 2004-2008 and a total of 35 sightings including 64 individuals were observed between 2016-2018. In southern Nicaragua, 145 sightings including 373 individuals were observed between 2016-2020. Humpback whale groups with calves, singers and competitive groups were detected from January to April confirming that Nicaragua is a breeding area. This study shows the presence of a breeding population with distinct habitat use patterns between northern and southern Nicaragua, suggesting that Central American humpback whales might use different breeding areas within the broader Central American breeding ground according to their needs and activity. Simple inter-year mark-recapture calculations gave estimates of close to 200, much lower than the estimated size of the Central American humpback whale population. This likely reflected a downward bias as a result of humpback whales not redistributing randomly between years and some perhaps preferentially returning to certain portions of Nicaraguan waters. Future research should further analysis on the ecology of groups with a calf and without a calf to understand specific habitat use patterns.

Population characteristics of humpback whales (Megaptera novaeangliae) observed off the Pacific coast of Nicaragua, Central America
Joëlle De Weerdt1, John Calambokidis2, Bram Vanschoenwinkel1, Marc Kochzius1, Phil Clapham

1Association ELI-S, Gujan-Mestras, France,
2Cascadia Research Collective, Olympia, 1Vrije Universiteit Brussel, Brussel, Belgium, 1Seastar Scientific, Vashon, Washington

Previous research has shown the presence of an endangered humpback whale population breeding off the Pacific coast of Central America. However, little is known about the density, size, social groups and spatial habitat use of this subpopulation. To fill this knowledge gap, boat-based surveys were conducted between November and April at two study sites along the Pacific coast of Nicaragua between 2004-2008 and 2016-2020. In northern Nicaragua, a total of 114 sightings including 203 individuals were observed between 2004-2008 and a total of 35 sightings including 64 individuals were observed between 2016-2018. In southern Nicaragua, 145 sightings including 373 individuals were observed between 2016-2020. Humpback whale groups with calves, singers and competitive groups were detected from January to April confirming that Nicaragua is a breeding area. This study shows the presence of a breeding population with distinct habitat use patterns between northern and southern Nicaragua, suggesting that Central American humpback whales might use different breeding areas within the broader Central American breeding ground according to their needs and activity. Simple inter-year mark-recapture calculations gave estimates of close to 200, much lower than the estimated size of the Central American humpback whale population. This likely reflected a downward bias as a result of humpback whales not redistributing randomly between years and some perhaps preferentially returning to certain portions of Nicaraguan waters. Future research should further analysis on the ecology of groups with a calf and without a calf to understand specific habitat use patterns.
A Novel Approach to Investigate Damage to the Marine Mammal Melon from Underwater Explosions
Monica DeAngelis¹, Emily Guzas², Lauren Marshall³, Thomas Fetherston⁴, Rachel Hesse², Daniel Perez², Eric Warner³
¹NUWC-Naval Undersea Warfare Center, Portsmouth, RI, ²NUWC-Naval Undersea Warfare Center, Newport, Rhode Island, ³NUWC-Naval Undersea Warfare Center, United States, ⁴U.S. Navy, Newport, Rhode Island, ⁵NUWC-Naval Undersea Warfare Center

Marine mammals could be exposed to underwater explosions (UNDEX) in a variety of settings, including coastal construction, underwater demolition, and military operations. Primary blast injury has been documented in a few marine mammal species exposed to UNDEX, which can occur in organs surrounded by fluid (e.g., brain), but is most often associated with air-filled structures (e.g., lungs and intestines). The latter injury mechanism is the basis for current non-auditory injury and mortality criteria used for marine mammals in the United States. However, these thresholds may not be appropriate for the marine mammal melon because it sits outside the skull, is protected only by a thin epidermis layer, and was not studied in the context of UNDEX vulnerability. Furthermore, its tissue material response has not been previously characterized for dynamic loads (transient forces acting on a structure). We designed and executed a set of complex experiments that leveraged drop-weight (impact) testing, used as a surrogate for conventional UNDEX, and applied to melon samples. In developing and conducting a nondestructive method for identifying potential damage to the melon, we measured each sample’s mass density and sound speed before and after impact testing. This protocol proved effective, confirming that samples with large post-test reductions in sound speed did exhibit visual indications of damage. We also used high-speed photography of a random speckle pattern that was applied to the melon sample exterior and paired it with digital image correlation techniques to track the speckles as the sample deformed during the drop weight impact event. These high-speed videos did provide data on vertical, horizontal, and out-of-plane displacement of the melon samples. This is the first assessment to characterize the melon’s mechanical response to UNDEX by using dynamic impact testing to verify tissue damage mechanisms and therefore, revisions to current non-auditory damage criteria may be warranted.

Occurrence and Distribution of Rice’s Whale Calls near DeSoto Canyon 2010-2018
Amanda Debich¹, Lance Garrison², John Hildebrand¹, Melissa Soldevilla¹
¹Cooperative Institute for Marine and Atmospheric Studies, University of Miami, Miami, FL, ²Miami, FL, ³Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, ⁴Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL

The Rice’s whale, estimated to have a population size of less than 100 individuals, was listed as endangered under the U.S. Endangered Species Act in 2019. To understand the long-term temporal occurrence of these whales in their core habitat near the DeSoto Canyon in the Gulf of Mexico, High-frequency Acoustic Recording Packages (HARPs) were deployed and recorded continuously from 2010 through 2018. Two Rice’s whale call types, long-moan calls and downsweep pulse sequences, were automatically detected using spectrogram cross-correlation with manual validation. A total of 628,552 Rice’s whale long-moan call detections were manually validated, yielding 466,982 true call detections, and a total of 115,729 Rice’s whale downsweep pulse sequence detections were manually validated, yielding 17,449 true call detections. Rice’s whale long-moan calls were present during an average of 95% of days with recordings per deployment. Rice’s whale
downsweep pulse sequence calls were detected an order of magnitude less frequently than long-moan calls at the HARP site over the eight-year period, with downsweep calls present during an average of 31% of days with recordings per deployment. While calls are detected year-round in all years, preliminary analyses suggest both interannual and seasonal variation, with more daily call detections in fall than in late winter and spring. Further, hourly call detection rates are higher in late afternoon to early evening for both call types. High densities of anthropogenic activities occur throughout the Gulf of Mexico, including oil and gas exploration and extraction, fisheries, shipping, and military activities, with several of these activities overlapping with the whales’ core habitat. Understanding inter-annual and seasonal distribution and density will improve the potential impact of human activities in the core habitat and assist in developing recovery measures for this endangered species.

Investigating contaminant-related health effects in killer whales in British Columbia using omics

Bethany DeCourten¹, Adam Warner², Gina Ylitalo³, Bradley Hanson⁴, Candice Emmons⁵, Jared Towers⁶, Lance Barrett-Lennard⁷, Peter Ross⁸, Marie Noel⁹


Killer whales (Orcinus orca) are an iconic species in coastal British Columbia, Canada, with three distinct populations inhabiting the area: the northern resident, southern resident, and west coast Bigg’s populations. Low food availability, contaminant exposure, and noise are the major threats to these populations with the southern residents being the most vulnerable. We measured PCB and PBDE levels in blubber biopsies collected from individuals in the southern resident, northern resident, and Bigg’s populations (n = 10-12). Additionally, we are investigating trends in metabolomic profiles and gene expression as they relate to contaminant concentration, population, and biological factors. Using RNA sequencing, we are assessing gene expression throughout the transcriptome and identifying key genes responsive to contaminant exposure. Building upon decades of research by our team, these findings will provide a clearer understanding of health effects associated with contaminants in killer whales that can be used to inform risk-based prioritization of conservation efforts.

Microbiological analysis of Okhotsk Sea population bowhead whales (Balaena mysticetus) exhale samples.

Tatyana Denisenko¹, Ekaterina Dzhikiya², Grigoriy Tsidulko³, Lev Nazarov³, Aglaya Tsidulko³, Natalia Markelova³, Alex Ilyushkina⁴

¹K.I.Skryabin Moscow State Academy of Veterinary Medicine & Biotechnology, Moscow, Russia, ²ANO "Scientific and Ecological Dolphin Rescue Center "Delfa"; Russin Scientific Center of Roengenology (RSCRR), Moscow, Russia, ³Moscow, Russian Federation, ⁴Moscow, Russia, ⁵Department of Biology of Moscow State University, Moscow, Russia, ⁶Russian Scientific Center of Roengenology and Radiology (RSCRR), Moscow, Russia

Studying the health status of cetaceans allows us to assess the risks and identify the causes affecting the well-being of populations. The study of the microflora of the exhaled air of
whales helps to identify not only pathogenic and opportunistic microorganisms circulating in the studied group of individuals, but also to assess the health of the population as a whole. In August 2020 in Wrangel bay (Sea of Okhotsk) we collected air samples exhaled by bowhead whales, utilizing non-invasive method, in compliance with the rules of asepsis. Water samples were taken simultaneously for control and sanitary-microbiological assessment of the environment. A total of 43 samples were collected from 20 individuals. Bacteriological and mycological surveys were carried out using standard techniques. The biological properties of the isolated cultures were studied in order to identify them and the species and quantitative ratio in the samples were assessed. Identifications of the isolats was doing by MALDI-TOF Mass spectrometry. Particular attention was paid to the pathogenicity and resistance to antibacterial drugs. Microorganisms were found in 18 samples, including bacteria of the genera Aeromonas, Corynebacterium, Bacillus and fungi of the genera Penicillium, Candida, Aspergillus. An insignificant total microbial count in the studied samples and frequent detection of microorganisms in monocultures or no more than 2 species in one sample may indicate a low microbial contamination of the respiratory tracts of the surveyed whales. In one of the samples, hemolytic microorganisms were found in monoculture, which may be an indicator of health problems in this individual. Our results demonstrate differences in the composition of microbial associations of the respiratory tracts of bowhead whales of the Sea of Okhotsk from other species of large cetaceans, the absence of unconditional pathogens in the samples and the detection of bacteria with the presence of pathogenic factors in only one

**Comparative Morphology of the Melon in Mesoplodont Beaked Whales**

Michael Denk¹, William McLellan², D. Ann Pabst³, Sentiel Rommel³, Tiffany Keenan⁴, Sarah Sharp⁵, Misty Niemeyer⁶, Nicole Hunter⁷, Gary Block⁸, Craig Harms⁹, Steven Thornton¹⁰, Alex Costidis¹¹, Michael J Moore¹²

¹Woods Hole Oceanographic Institution (Guest Investigator), Cape May Whale Watch and Research Center, ²University of North Carolina Wilmington, Wilmington, NC, ³University of North Carolina, Wilmington, NC, ⁴UNC Wilmington, Wilmington, NC, ⁵IFAW, Yarmouth Port, MA, ⁶International Fund for Animal Welfare, Yarmouthport, Massachusetts, ⁷IFAW, ⁸Ocean State Veterinary Specialists, ⁹College of Veterinary Medicine, and Center for Marine Sciences and Technology, North Carolina State University, Morehead City, NC, ¹⁰NOAA, Norfolk, Virginia, ¹¹Virginia Aquarium and Marine Science Center, ¹²Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Description of species-specific melon morphology is critical to understanding sound production in odontocete cetaceans. Due to rarity of specimens, very few studies have provided descriptions of adult mesoplodont nasal anatomy, and the melon morphology of many species such as *Mesoplodon europaeus* and *M. mirus* remains undescribed. In addition, no studies to date have examined the tendon insertions of the rostral muscles into the melon tissue in these taxa. Heads of four mesoplodont beaked whales across three species (*M. densirostris* *M. europaeus*, and *M. mirus*) were examined via archived computed tomography. Volume reconstructions of the melon and related structures were performed to reveal morphology, scaling, and spatial relationships. Three *M. europaeus* heads were dissected in detail, and representative axial melon sections were treated for polarized light viewing of the tendons. All specimens demonstrated complex sinusoidal melon shapes associated with alternating intrusions of the medial rostral muscles into the melon. The tendons of these muscular intrusions insert into the melon tissue via a unique arrangement of
diagonal tendons. In all three species, the dorsal bursae were not as developed or differentiated from other lipid structures as in delphinids and phocoenids. These findings lay the foundation for further studies, and indicate that mesoplodont whales possess unique melon morphology under fine-tuned muscular control for echolocation. Further describing this anatomy will lead to greater functional understanding of frequency-modulated echolocators.

**Unusual Open Water Grouping Behavior in Salish Sea Harbor Seals (Phoca vitulina richardii)**

*Trevor Derie*, Katrina Maclver, David Anderson, Laurie Shuster, Cindy Elliser

*1Pacific Mammal Research, Anacortes, Washington, 2Pacific Mammal Research, Anacortes, WA, 3Cascadia Research Collective, Olympia, Washington, 4Pierce College, Lakewood, WA*

Most pinniped species are relatively solitary when in water, but some species, most notably the otariids, will form large groupings (referred to as rafts) in open water for thermoregulation or rest, as well as participating in group foraging behaviors. Alternatively, individuals of many species may concentrate in one area, forming foraging aggregations when prey are in high abundance. Open water grouping behavior that is distanced from haulout sites is less common in phocid species, and in particular has not been documented in the literature for harbor seals (*Phoca vitulina richardii*). In the Salish Sea, the inland waters of Washington, United States and British Columbia, Canada, harbor seals are the most abundant pinniped species. Recent observations in two locations in the south and central Salish Sea have documented large groupings ranging from 6 to 50 individuals (*x*=23.9) not located near haulout sites (more than at least 1 mile from known large group haulout locations). These observations occurred only in April/May 2019-2020 off Fidalgo Island (n=14) and in February 2017 and January 2019 in southern Puget Sound (n=2). These groups consisted of only adults/juveniles floating together within 1-2 body lengths of each other, unlike larger aggregations where individuals are in the same area, but not necessarily as a group. Some observations included systematic diving where individuals took turns periodically diving, appearing to be foraging, while others remained at the surface. This behavior appears to differ from the rafting behavior observed in otariids. Though harbor seals are known to habitually haul out together on beaches or islands, grouping behavior while in the water, like that observed here, has not been previously described. The purpose of such large groupings is unknown and continued monitoring of these occurrences and further analysis of behavior is needed.

**Anticipating large whale entanglement risk off Oregon, USA through a predictive approach to spatial conflict**

*Solene Derville*, Troy Buell, Kelly Corbett, Craig Hayslip, Brett Rodomsky, Leigh Torres

*1Marine Mammal Institute, Oregon State University, Noumea, --- Select One ---, New Caledonia, 2Oregon Department of Fish and Wildlife, Newport, Oregon, 3Oregon State University, Newport, OR, 4Marine Mammal Institute, Oregon State University, Newport, Oregon*

Entanglement in fishing gear is a major threat to marine mammals worldwide and has become a pressing concern for whales in the US West Coast waters during the last decade. Several distinct populations of blue, humpback, fin and gray whales migrating and feeding off the Oregon, USA coast are threatened by rising rates of entanglement. The lack of understanding of large whale distribution in this region limits conservation efforts to mitigate fisheries impacts. Based on an extensive distance sampling dataset (2018-2021, > 150 survey days), this study aims to model year-round habitat use patterns of large
whales and predict co-occurrence patterns with fishing effort to provide managers with temporally and spatially explicit maps of entanglement risk in Oregon waters. Whale data were collected from multiple platforms of observation: seasonal oceanographic research cruises, and monthly helicopter surveys conducted through a partnership with the United States Coast Guard (n > 600 whale groups observed). Environmental predictors implemented in models were derived from remotely-sensed sources and regional ocean modeling systems to comprehensively reflect surface and subsurface ocean dynamics that may influence species distribution patterns at multiple temporal scales. Density surface modeling revealed seasonally varying relationships between large whales and vertical mixing indicative of upwelling strength, allowing for accurate predictions of seasonal whale occurrence patterns validated with opportunistic sightings acquired through citizen science data. Finally, overlap was assessed between whale predicted occurrence maps and fishing effort characterized through analysis of high-resolution fishery logbook data. This collaborative research effort has already helped develop new fishery regulations to reduce the risk of entanglement by limiting commercial Dungeness crab gear deployment in Oregon waters in time and space. Our continued work will evaluate such management strategies and contribute to the design of regulatory decisions that will maximize effectiveness at protecting whales while also minimizing burdens to fisheries.

Classification algorithm from echolocation and burst pulse clicks of franciscana dolphins (Pontoporia blainvillei)

Diogo Destro Barcellos¹, Marcos Santos²
¹Laboratório de Biologia da Conservação de Mamíferos Aquáticos, IOUSP, São Paulo, São Paulo, Brazil, ²Laboratorio de Biologia da Conservacao de Mamiferos Aquaticos, IOUSP, Sao Paulo

The franciscana dolphin, *P. blainvillei*, is a small odontocete and the sole living member of Pontoporiidae. Its distribution is restricted to the coastal shallow waters in the limited regions of southwestern Atlantic Ocean. The purpose of this study was to develop a classification algorithm from echolocation and burst pulse clicks of *P. blainvillei*. Echolocation signals were recorded around Anchieta Island (23°32’S, 45°3’W), southeastern Brazil, using passive acoustic monitoring. Temporal and frequency parameters were extracted from 182 sequences of echolocation clicks and 51 arrangements of burst pulse clicks. Two-third of the dataset were randomly selected and used to train the random forest analysis and one-third of the dataset was used for validation. The mean decrease Gini was implemented to estimate the predictive parameters of importance for categorization. The classification algorithm presented 99.3% accuracy in predictions and 98.7% precision of classification of the corresponding echolocation signals. Based on mean decrease Gini, the most important parameters considered for classification were inter-click (IC) mean, IC median, duration and frequency minimum. An important step was taken towards the use of classification algorithms from echolocation and burst pulse clicks of *P. blainvillei*, a species which rarely emit whistles, and to the implementation of long-term acoustic monitoring of the most endangered cetacean species in the southwestern Atlantic. The classification algorithm presented here represent a robust and reliable tool to better understand *P. blainvillei* ecology, occurrence patterns, and habitat use for further conservation actions.

Behavioral Response of a Threatened Aquatic Mammal to Relocation of Warm-water Habitat Critical for Overwinter Survival

Chip Deutsch¹, Margaret Barlas², Kerri Scolardi³, Jane Provancha⁴, James Reid⁵, Susan Butler⁶, John E. Reynolds⁷
¹Laboratório de Biologia da Conservação de Mamíferos Aquáticos, IOUSP, São Paulo, São Paulo, Brazil, ²Laboratorio de Biologia da Conservacao de Mamiferos Aquaticos, IOUSP, Sao Paulo, Brazil, ³Kerri Scolardi, ⁴Jane Provancha, ⁵James Reid, ⁶Susan Butler, ⁷John E. Reynolds
Florida manatees (*Trichechus manatus*) require access to thermal refuges during winter because of their vulnerability to cold-related stress and mortality. The most important warm-water site for manatees on Florida’s Atlantic coast is a power plant thermal discharge into the Indian River Lagoon. The plant went offline for 3 years during modernization, during which time an interim heated refuge was created nearby and operated during cold periods for manatees. We documented manatee behavioral response to changes in the location and operation of this industrial thermal refuge over 6 successive winters (2009-2015) through a combination of satellite-linked GPS telemetry (N=61), aerial surveys (every 1-2 weeks), and daily ground counts at the interim refuge. A manatee aggregation (high count of 760) quickly formed in the newly created refuge when early-winter cold fronts dropped ambient water temperatures below 20°C. The percentage of tagged manatees that left the power-plant area to seek warm-water habitat elsewhere did not differ between winters with the interim refuge and those with the traditional discharge. Testing of new turbines during the third winter generated intermittent heated effluent in the former discharge area, which tagged individuals discovered 4 hours to 38 days after discharge started. During this period with two asynchronous warm-water sources, 45% of 62 visits were only to the interim refuge, 11% were only to the traditional discharge area, and 44% were to both sites; tagged manatees spent 4-fold more time in the warmer and more reliable interim refuge than in the traditional area. After the modernized plant resumed operation and the interim heating system was offline, most tagged manatees still visited the interim site multiple times for brief periods; use of this site declined substantially in the next winter. These findings provide evidence for development and subsequent loss of manatee site fidelity to a new, temporary warm-water refuge.

Stranding trends and skin lesion prevalence of bottlenose dolphins (*Tursiops truncatus*) exposed to a freshwater input event in Mobile Bay, AL

**Cristina Diaz Clark**¹, Mackenzie Russell², Alissa Deming³, Jennifer Bloodgood⁴, Ruth H. Carmichael⁵

¹Dauphin Island Sea Lab, Mobile, Alabama, ²Dauphin Island Sea Lab/AL Marine Mammal Stranding Network, Dauphin Island, Alabama, ³Pacific Marine Mammal Center, ⁴Dauphin Island Sea Lab, Dauphin Island, Alabama, ⁵Dauphin Island Sea Lab/ University of South Alabama, Dauphin Island, Alabama

An increased number of bottlenose dolphins (*Tursiops truncatus*) with skin lesions indicative of freshwater exposure stranded in Alabama during Spring 2020. Little is known about the salinity threshold and length of exposure required for lesions to appear. Grossly, these lesions present acutely as combinations of pale, proliferative skin with areas of ulceration and erosions. These lesions progress to multifocal to coalescing erosions with blubber involvement and algal matting in presumably more chronic cases. In this study, stranding location, sex, age class, and presence/absence of skin lesions were analyzed for freshly dead and moderately decomposed dolphins (n=39) stranded between 1 Jan to 31 Aug 2020. Sixteen animals were not included in this study due to advanced state of decomposition. Discharge from the Alabama and Tombigbee Rivers and salinity data from Dauphin Island were examined during the same period to identify freshwater influx trends. A 40-year flood occurred in Mobile Bay between...
February and March, with the highest rate of discharge occurring in February, 2.4x greater than the 6-month average, and the lowest salinity occurring in March, 8 psu lower than the 6-month average. Fifty-one percent (20/39) of T. truncatus examined had evidence of freshwater-associated lesions. Prevalence of lesions was highest in adults (13 adults, 6 subadults, 1 calf), but did not differ between sexes. Individuals with freshwater lesions primarily stranded in April (n=13) and were more likely to strand in Mobile Bay (n=17) than in the Gulf of Mexico (n=1). The prevalence of freshwater-associated lesions on dolphins stranded in the Mobile Bay estuary, the fourth largest freshwater drainage system in the country, demands further investigation and highlights the importance of stranding response and skin lesion documentation, especially in times of environmental disruptions.

Diet of teutophagous cetaceans in the Gulf of Mexico
RAUL E. DIAZ-GAMBOA1, Elvin M. Rodríguez Dzul2
1Universidad Autonoma de Yucatan, Merida, Yucatan, Mexico, 2Universidad Autónoma de Yucatán, Merida, Yucatan, Mexico

In the order Cetacea are several species of habits primarily teutophagous, as well as generalist or opportunistic species that include cephalopods in their diet, both in oceanic and coastal waters. The aim of this study was to analyze the consumption of cephalopods by odontocete cetaceans in the Gulf of Mexico. In the Yucatan Marine Mammal Research and Conservation Program (PICMMY in spanish) of the Autonomous University of Yucatan, 51 stomachs from odontocete cetaceans stranded dead were collected in Yucatan between 2013 and 2021, identifying eight different species: melon-headed whale (Peponocephala electra), pygmy sperm whale (Kogia breviceps), rough-toothed dolphin (Steno bredanensis), pantropical spotted dolphin (Stenella attenuata), pygmy killer whale (Pseudorca crassidens), spinner dolphin (Stenella longirostris) and common bottlenose dolphin (Tursiops truncatus). From 51 stomachs analyzed, only 32 of them (63%) presented stomach content. From those who had stomach content, only 19 (59%) included cephalopods in their diet. Several cephalopod beaks were found corresponding to 106 organisms belonging to 17 species and nine families: Cranchiidae, Ommastrephidae, Histiotethidae, Onychoteuthidae, Lycoteuthidae, Enoploteuthidae, Thysanoteuthidae, Octopoteuthidae and Octopodidae. The most consumed cephalopods belonged to the Octopodidae, Ommastrephidae and Histiotethidae families. Three species of cetaceans were specialist teutophagous (K. breviceps, P. electra and P. crassidens) and two of them opportunists (T. truncatus and S. bredanensis). The specialist teutophagous consumed only oceanic squids while opportunistic teutophagous only coastal octupuses (demersals). The specialist teutophagous did not share squid species. Pygmy sperm whales where the cetaceans that recorded the largest number of cephalopod species in its diet with 13 species belonging to seven families.

Seasonal distribution and long-term trends of beaked whales on three deep-water U.S. Navy training ranges
Nancy DiMarzio1, Stephanie Watwood2, Karin Dolan3, Susan Jarvis3, Ronald Morrissey3
1Naval Undersea Warfare Center Division, Newport, Newport, RI, 2US Naval Undersea Warfare Center, Newport, Rhode Island, 3Naval Undersea Warfare Center, Newport, RI

The potential effects of mid-frequency active sonar (MFAS) on beaked whales have been a concern due to mass stranding events such as the one documented in the Northwest Providence Channel, Bahamas in 2000. However, populations of beaked whales are also regularly present on U.S. Navy training ranges, with some
considered resident. Blainville’s beaked whales are found at the Atlantic Undersea Test and Evaluation Center (AUTEC) in the Bahamas and the Pacific Missile Range Facility (PMRF) off Hawaii, and Cuvier’s beaked whales are present at the Southern California Antisubmarine Warfare Range (SOAR) off California, as well as at AUTEC and PMRF. The U.S. Navy’s Marine Mammal Monitoring on Navy Ranges (M3R) program has collected long-term data sets that are used to examine beaked whale distribution, abundance and long-term trends by evaluating the Group Vocal Periods (GVPs) detected when beaked whales vocalize at depth during deep foraging dives. A GVP is the period of time that a group of whales is vocalizing from the first detected click to the last. Each of the ranges utilizes 100 to 200+ bottom-mounted hydrophones covering an area of 1500-2000 sq km. These hydrophones are used to passively detect beaked whale clicks in real-time and results are archived. During post-processing the clicks are formed into click-trains, and an Autogrouper program is used to combine these click trains into GVPs that each represent a single foraging dive. Statistical modelling was used on these processed GVPs to evaluate the temporal distribution and abundance of Blainville’s and Cuvier’s beaked whales at AUTEC from 2013-2020 and PMRF from 2011-2020, and for Cuvier’s beaked whales at SOAR from 2010-2020. Each range has clear seasonal patterns and long-term trends. Spatial distribution will also be discussed, as well as a comparison among the ranges, which are located in both the Pacific and Atlantic oceans.

Whistle behaviour of Indian Ocean humpback dolphins (Sousa plumbea) in South Africa
Sasha Dines¹, Shanan Atkins², Simon Elwen³, Enrico Gennari⁴, John Measey⁴, Els Vermeulen⁵, Tess Gridley⁶
¹Stellenbosch University, SeaSearch, mossel bay, South Africa, ²Stellenbosch University, Cape Town, South Africa, ³‘Oceans Research Institute, Mossel Bay, South Africa, ⁴Mammal Research Institute Whale Unit, University of Pretoria, South Africa, Hermanus, Western Cape, South Africa, ⁵University of Cape Town, Cape Town, Western Cape, South Africa

The Indian Ocean humpback dolphin (Sousa plumbea) is South Africa’s most endangered marine mammal. Low population numbers, cryptic behaviour and their extreme inshore environment has restricted monitoring using traditional visual survey techniques. Dolphins rely heavily on acoustic channels for communication and exploration of their environment, however for the South African population of S. plumbea, our understanding of their acoustic behaviour is limited with no published acoustic repertoire studies and little general acoustic literature for Sousa spp.. This study is the first to describe whistle characteristics of S. plumbea recorded in South Africa, with a focus on whistle features which support the use of individual signature whistle use. Identification of likely signature whistles was conducted using the SIG ID method (Janik et al., 2013), developed for common bottlenose dolphins (Tursiops truncatus). Data were analysed from 21 recording days across 5 geographically separate locations along the south and east coast. In total, 1293 whistle contours were identified, among which 21 signature whistle types (SWT) were identified. The fundamental frequency of whistles ranged far wider than sympatric species with a frequency range between 0.38 and 46.57 kHz, as well as a mean duration of 0.4s. Whistles fulfilling the SIG ID criteria were often multi-looped and frequency ranged from 3.7 to 41.5 kHz. Non linear phenomena (NLP) was seen across all study sites, including side bands, subharmonics, and frequency jumps. The study found that 35% of non-stereotyped whistles were classified as high frequency whistles. These were not produced in bouts and did not fulfil criteria to be
considered signature whistles. They were highly variable and associated with socializing contexts. Here we provide a description of *S. plumbea* whistle behaviour with an emphasis on identifying key whistle features useful for individual identification in this species.

**Residency patterns and social structure of Blainville’s beaked whales *Mesoplodon densirostris* in Madeira.**

Anja Badenas¹, Ana Dinis², Rita Ferreira³, Annalisa Sambolino⁴, Eliette HAMARD⁵, Filipe Alves⁶

¹MARE- Marine and Environmental Sciences Centre, Funchal, Portugal, ²MARE/ARDITI/OOM, Funchal, Portugal, ³MARE-Madeira, Portugal, ⁴MARE - Marine and Environmental Sciences Centre / ARDITI, University of Madeira, Funchal, Madeira, Portugal, Portugal, ⁵Aix-Marseille Université, France, ⁶MARE - Marine and Environmental Sciences Centre, Portugal

Studying the movement patterns and associations of highly social animals can give valuable insight on their complex social structures. In the present study we focus on exploring the social structure of the Blainville’s beaked whale (*Mesoplodon densirostris*) off Madeira Island. A capture-history dataset compiled from photographic-identification data collected between 2011 and 2019 was used to determine residency and association patterns of beaked whales through Lagged Identification Rates (LIRs) and Standardized Lagged Association Rates (SLARs), respectively. Furthermore, permutation tests were used to further study the preferred associations between age classes. A total of 84 highly distinctive beaked whales were catalogued (29 adult females, 19 adult males, 12 subadult males and 19 immature whales). Recapture Rates (RR) of the different age groups revealed that Blainville’s beaked whales use the area differently depending on their age group. LIRs indicated that females and immature Blainville’s beaked whales spent more time in the area than adult and subadult males. SLARs showed that most associations did not last longer than 3 months, however it also revealed that adult females associated more often than expected (if associated randomly) during periods of at least 3.5 years. Finally, permutation tests showed that individuals of all age groups associated preferentially with individuals of other age groups for short- (hours), medium- (months) and long-term (years). The results of this study support that Blainville’s beaked whales present high site fidelity to specific areas and provide new information on the associations and population structure of this species. The Blainville’s beaked whale is listed as data deficient by the IUCN red list and therefore there is an urgent need to perform studies to provide valuable information for their conservation.

**Another String to their Bow: Year-round Acoustic Presence of Bowhead Whales and Seasonal Detections of other Marine Mammals in the Canadian Arctic**

Nikoletta Diogou¹, William Halliday², Stan Dosso³, Xavier Mouy⁴, Stephen Insley⁵

¹University of Victoria, ²Wildlife Conservation Society Canada, ³University of Victoria, Victoria, British Colombia, ⁴JASCO Applied Sciences Ltd, Victoria, ⁵Wildlife Conservation Society Canada, Whitehorse, Yukon

In the Arctic, temperatures are increasing at a pace at least twice as fast as the rest of the world. This warming leads to a continuously shrinking sea ice coverage and a series of cascading effects through the food chain. Marine mammals, positioned at higher trophic levels, make effective bioindicators of environmental shifts. Ice-obligate (bearded and ringed seals) and ice-associated (bowhead and beluga whales) Arctic species are inherently impacted by the variability of sea ice. Long-term monitoring can reveal alterations in their distribution range, spatio-temporal patterns, and migration...
phenology that can be responses to global change. However, due to its intrinsic harsh conditions and remoteness, Arctic ecosystems are particularly challenging to monitor. Here, we deployed passive acoustic recorders at three locations in the Amundsen Gulf (southeastern Beaufort Sea, Arctic Ocean) between October 2018 and September 2019 to detect marine mammal acoustic presence, quantify their seasonal occurrence and measure the spatiotemporal variability of underwater sound levels. Results showed that mean underwater sound levels increased in the summer and were lowest in winter. The manual analysis of 6200 sound files, of 5-min duration each, also showed clear seasonal patterns in the occurrence of bowheads, belugas and bearded seals with increased acoustic presence in spring and summer at all sites. Ringed seals showed a more stable, even though lower, presence throughout the year. Bowheads, in contrast to their typical migratory behavior, were detected throughout the year at all sites, providing the first evidence of a number of overwintering animals in what is normally their summer feeding ground. This unusual event coincided with anomalously low sea ice concentration in the area. Whether this alteration in their migratory behaviour, is an anomaly or a permanent shift linked to climate change remains to be determined and is of high conservation value.

Lesion Analysis of Bottlenose Dolphins (Tursiops truncatus) in the St. Johns River, FL
Brittney DiVittore-Goodrum1, Quincy Gibson2
1University of North Florida, Jacksonville, FL, 2University of North Florida, Jacksonville, Florida

Photo analysis of skin lesions is a non-invasive method to measure the health of cetacean populations. The St. Johns River (SJR) in NE Florida is an estuarine system inhabited by bottlenose dolphins that is characterized by high levels of anthropogenic activity, which can impact dolphin health. Individuals within this population vary in time spent within the river; thus, this study aimed to determine if skin lesion prevalence and body coverage differed among residency categories. Residency was based on the monthly sighting rate (MSR) in cold (<22.55°C) and warm (>22.55°C) seasons, assigned monthly. Categories include year-round residents with high or medium MSR in both seasons, seasonal residents with high or medium MSR in one season and low in the other, and transients with low MSR in both seasons. For lesion analyses, the dataset was restricted to three 12-month periods, based on the occurrence of an unusual mortality event (pre, during, and post-UME). Weekly photo-ID surveys were conducted from March 2012-2016 along a 40km transect. For the first 2 years of study 569 high-quality photos were examined for lesions on the dorsal fin and total visible body. Body coverage was categorized as background (<5%), low (5-20%), medium (20-50%), or high (>50%). Average lesion prevalence was highest in residents (.86±.12) followed by seasonal (.64±.16) and transients (.39±.03). Background level coverage was the most common in all residency categories and was highest in residents (.62±.05), followed by seasonal (.45±.09) and transients (.32±.0004). Other categories resulted in a similar trend, suggesting that increased use of the SJR corresponds with an increased risk of lesions. Social transmission of disease may also lead to lesion formation in this population. Lesion analysis results of resident and seasonal individuals will be compared to half-weight indexes and degree centrality to determine if increased social interaction catalyzes transmission of lesion-causing diseases.

Does Diatom Coverage of Humpback Whale Flukes Reflect Temporal Variation in Primary Productivity?
Flordespina Dodds1, Thomas Grove2, Alyssa Stoller1, Marianne Helene Rasmussen4

1University of North Florida, Jacksonville, FL, 2University of North Florida, Jacksonville, Florida

Photo analysis of skin lesions is a non-invasive method to measure the health of cetacean populations. The St. Johns River (SJR) in NE Florida is an estuarine system inhabited by bottlenose dolphins that is characterized by high levels of anthropogenic activity, which can impact dolphin health. Individuals within this population vary in time spent within the river; thus, this study aimed to determine if skin lesion prevalence and body coverage differed among residency categories. Residency was based on the monthly sighting rate (MSR) in cold (<22.55°C) and warm (>22.55°C) seasons, assigned monthly. Categories include year-round residents with high or medium MSR in both seasons, seasonal residents with high or medium MSR in one season and low in the other, and transients with low MSR in both seasons. For lesion analyses, the dataset was restricted to three 12-month periods, based on the occurrence of an unusual mortality event (pre, during, and post-UME). Weekly photo-ID surveys were conducted from March 2012-2016 along a 40km transect. For the first 2 years of study 569 high-quality photos were examined for lesions on the dorsal fin and total visible body. Body coverage was categorized as background (<5%), low (5-20%), medium (20-50%), or high (>50%). Average lesion prevalence was highest in residents (.86±.12) followed by seasonal (.64±.16) and transients (.39±.03). Background level coverage was the most common in all residency categories and was highest in residents (.62±.05), followed by seasonal (.45±.09) and transients (.32±.0004). Other categories resulted in a similar trend, suggesting that increased use of the SJR corresponds with an increased risk of lesions. Social transmission of disease may also lead to lesion formation in this population. Lesion analysis results of resident and seasonal individuals will be compared to half-weight indexes and degree centrality to determine if increased social interaction catalyzes transmission of lesion-causing diseases.
As marine megafaunal species that are bound to the water surface, observation of cetaceans can facilitate ecosystem assessments in challenging ocean environments. Here, we assess the feasibility of using diatom coverage on humpback whale flukes to monitor temporal variation in primary productivity in Skjálfandi Bay, Iceland. To measure diatom coverage, we used 577 fluke identification photographs of 256 humpback whales collected from whale-watching vessels between 2018 and 2020. Images are filtered for photographic clarity and the proportion of white coloration to enable standardised quantification of yellow coloration, a proxy for diatom coverage. Percent diatom coverage (PDC) is then visually estimated by three individuals in 5% increments and average PDC is calculated for 8-day periods. To explore the ability of this metric to reflect primary productivity, average PDC is regressed against satellite-derived, spatially averaged chlorophyll concentration in the bay. Finally, primary productivity often precedes and predicts peaks in whale sightings, with a delay of weeks to months. Therefore, we investigate the potential of average PDC to predict periods of high numbers of whale sightings (from the same photographic data set) with linear regression and various temporal delays. In an area without regular plankton sampling, this simple metric, derived from data collected for other purposes, might facilitate monitoring of ecosystem function at high temporal resolution.

Some like it hot: Physiological and ecological factors in Xenobalanus globicipitis attachment to cetaceans.

Milan Dolezal¹, Vivienne Foroughirad², Ann-Marie Jacoby¹, Melissa Collier¹, Colin Murphy³, Frank Fish⁴, Janet Mann⁴

¹Georgetown University, Tiburon, CA, ²Georgetown University, MOREHEAD CITY, North Carolina, ³Duke University, ⁴Georgetown University, Washington, DC. ⁵Georgetown University, ⁶West Chester University, West Chester, PA

Xenobalanus globicipitis is a pseudo-stalked ectoparasitic barnacle specialized to cetacean skin. Previous work suggests high rates of attachment on the trailing edge of the dorsal fin, and hypothesizes that the hydrodynamics at this section of the fin are ideal for barnacle feeding while also minimizing drag. However, thermal images of the dorsal fin reveal that the trailing edge also contains some of the warmest areas on the fin. Our research investigates temperature as an additional factor for Xenobalanus globicipitis attachment location. We examine the effects of temperature in two ways: (1) probing a correlation with dorsal fin temperature and (2) examining global distribution of the barnacle, with a special interest in local ocean temperatures and host migratory patterns. For this first analysis, we use high quality photographs of Xenobalanus globicipitis attachment on bottlenose dolphin (Tursiops truncatus) dorsal fins from the Potomac-Chesapeake Dolphin Project (Maryland, USA) and mark the specific attachment points using a custom Python program. We then align these points (N = 64) to a thermal image of a dolphin’s dorsal fin and extract a temperature value for each point. Results from this analysis suggest that Xenobalanus globicipitis mainly attaches to the warmest section of the dorsal fin. The relationship between hydrodynamics and temperature as attachment factors is currently being investigated. Additionally, global distribution constructed from a literature review and surveys sent to authors of long-term cetacean studies suggests that Xenobalanus globicipitis presence is more common in cetaceans at lower (warmer) latitudes.
Hemispheric comparison of infectious diseases in Pinnipeds of Mexico and Peru.

Marisol Dominguez Orantes1, Carlos Francisco Yaipen-Llanos2

1Organization for Research and Conservation of Aquatic Animals - ORCA PERU, Guaymas, Sonora, Mexico, 2Organization for Research and Conservation of Aquatic Animals - ORCA PERU, Surco, Lima, Lima, Peru

Infectious diseases around the world have been a recurrent issue over the past 20 years in marine mammal health. As technology and stranding networks have developed, more infective pathogens and diseases have been identified. This work describes an effective clinical comparison of infectious diseases in Pinniped species from Mexico and Peru between 2000 and 2020. A retrospective analysis of documented cases was organized in a consistency matrix for pinnipeds species and infectious pathogens comparing clinical signology and diagnosis by stranding location and chronology. Data set also included gender and age class collected from reports on Zalophus californianus, Arctocephalus townsendi, and Mirounga angutirostris stranded in Mexico, and from Otaria byronia, Arctocephalus galapagoensis and Mirounga leonina stranded in Peru. Infectious diseases were classified between viral agents (Morbillivirus, Adenovirus, Calicivirus, Herpesvirus, Poxvirus) and bacterial pathogens (Brucella, Leptospira, Mycobacterium, Salmonella, Helicobacter). Findings reveal that O. byronia and Z. californianus have different responses to similar infectious diseases despite sharing similar ecological niche, and only Morbillivirus and Poxvirus associations have been diagnosed in both species. A. townsendi and A. galapagoensis both have smaller populations and similar levels of exposure to invasive species but different diseases were diagnosed in their isolated locations. M. angutirostris and M. leonina share a similar natural biology but with a different genetic pool showing a highest infectious susceptibility in the first than the latter. Clinical signology can be similar in pinnipeds with the same disease but with a different immune response linked to genetics, diet, fitness and geo-spatial distribution. This work promotes further clinical diagnosis that will facilitate researchers to improve treatments for common infectious diseases. It is also important to notice that current stranding networks in the Latin American Pacific coast require a technological impulse to enhance diagnosis of potential emerging infectious diseases as more information is obtained from pinniped strandings.

How does distribution change with abundance? Insights from a growing population of resident killer whales

Thomas Doniol-Valcroze1, Graeme M. Ellis2, John K.B. Ford3, Linda M. Nichol3, James Pilkington4, Eva Stredulinsky2, Jared Towers5, Brianna Wright1

1Fisheries and Oceans Canada, Nanaimo, British Columbia, 2Fisheries and Oceans Canada, Nanaimo, 3Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, British Columbia, 4Fisheries and Oceans Canada, Nanaimo, BC, 5Fisheries and Oceans Canada, West Vancouver

The relationship between population growth and range dynamics remains a major question in ecology, and has implications for monitoring and management. Two populations of resident killer whales in the NE Pacific have displayed diverging abundance trends, with the Southern Residents stagnating or decreasing while the Northern Residents have increased at a mean annual rate of 2.2% over the same time period. We investigated how this increase resulted in changes in distribution and range limits as well as overlap between the three acoustic clans that make up the Northern Resident population. Each year, extensive field effort is undertaken to photograph as many individuals as possible. Historically, this census tended to be restricted to
the waters off northeastern Vancouver Island but
the geographic range of the effort has expanded
over time to include all coastal waters of British
Columbia. We reconstructed the discovery
curves of individuals within each sub-region to
show that, due to changes in animal distribution
over time, complete censuses could not be
achieved anymore if efforts were focused in a
single area. We also combined passive acoustic
monitoring with visual surveys to document the
preferential use of clans, pods and matrilines for
specific parts of the population’s range. We show
how these patterns have changed over the study
period and tie in with observations of social
structure shifts (e.g., matriline splitting). The
results provide insights into how distribution
changes with abundance, and can inform
management issues (e.g., critical habitat) as well
as the challenges of monitoring a growing
population.

Denizens of the Deep: Three Lines of Evidence
Suggest a Pelagic Population of Risso’s
Dolphins in Hawaiian Waters
Annie Douglas¹, Robin Baird²
¹Cascadia Research Collective, Olympia,
Washington, ²Cascadia Research Collective,
Olympia, WA

More than half of the species of odontocetes (11
of 18) documented in Hawaiian waters have
resident, insular populations around the main
Hawaiian Islands. One published acoustic study
suggested that Risso’s dolphins were relatively
common in shallow waters around Kaua’i and
Ni’ihau, but those acoustic detections were never
confirmed with sightings. We used three lines of
evidence to assess whether Risso’s dolphins may
have an insular, resident population and may be
found in shallow waters: sighting rates in relation
to depth from 21 years of small-boat surveys
among the main Hawaiian Islands; re-sightings
from photo-identification data; and satellite tag
data from one LIMPET tag deployment. Of
3,235 odontocete sightings, there were only 16
sightings of Risso’s dolphins (group size range 1-
35, median=7.5), representing 0.5% of all
odontocete sightings. Despite extensive effort off
Kaua’i and Ni’ihau (22,968 km of trackline,
1,367 hours, across 12 years) there were no
Risso’s dolphin sightings off those islands. Of
the 16 sightings off Hawai’i Island, the
shallowest sighting was 3.4 km from shore in
1,366 m depth, and sighting rates for this species
increase with depth, with the highest sighting
rates in depths of 4,000 m and greater. Using
photos from 14 encounters between 1996 and
2020 we compiled a photo-identification catalog
of 142 individuals; no individuals were seen on
more than one occasion, suggesting a large
population with very low site fidelity. One
LIMPET satellite tag was remotely deployed on
an adult in April 2015. Over the 14-day period
the tagged individual used deep waters offshore
of the islands (median/max depth=4,217m,
4,816m; median/max distance from
shore=57.6km, 113.9km). Combined all three
lines of evidence suggest that there is no resident,
insular population of Risso’s dolphins around the
main Hawaiian Islands, similar to a handful of
other species including striped dolphins, Fraser’s
dolphins and killer whales.

Small cetacean, big ships: harbour porpoise
(Phocoena phocoena) habitat use at North
America’s fastest growing port
Karina Dracott¹, Caitlin Birdsall², Lance
Barrett-Lennard³, Alice Brown-Dussault⁴, Chloe
Robinson⁵
¹Ocean wise conservation association, ²Ocean
Wise Conservation Association, Prince Rupert,
BC, ³Coastal Ocean Research Institute,
Vancouver Aquarium, Vancouver, British
Columbia, ⁴Trent University, ⁵Ocean Wise,
Victoria, BV

Pacific Harbour Porpoise (Phocoena phocoena
vomerina) in British Columbia aggregate in
shallow coastal waters where bathymetric
features produce fast tidal currents. Characterized
by deep channels, eelgrass, large tidal influx and proximity to the Skeena R. estuary, the entrance to the Port of Prince Rupert is an area where high marine productivity and porpoise presence coincide with vessel traffic. Unusually large harbour porpoise (HP) aggregations occur in the vicinity, which we hypothesize serves as a regionally important habitat area and breeding location for the species. Gathering data on these small cetaceans is notoriously difficult, leading to a poor general understanding of their ranges, population structures, diet, and breeding phenology. This multi-year study employed passive acoustic monitoring in combination with visual surveys and citizen science data to fill data gaps regarding seasonality, diurnality and density. We investigated HP abundance in relation to abiotic and biotic factors and found that HP presence was positively correlated with periods when prey fish such as Pacific herring (Clupea pallasii), were present, fish spawning events and plankton blooms. We used the C-POD’s built-in KERNO classifier to identify and characterize narrow-band high frequency porpoise echolocation click trains. Porpoise activity was detected in 96% of the 1086 C-POD deployment days during the study. Results showed an increased occurrence and foraging activity of porpoise during hours of darkness and flood tidal phases. Mother-calf pairs were observed during visual surveys between May and December, and mating attempts were observed during large aggregations in winter months, suggesting that the location is potentially an important mating and calving ground seasonally. This study will contribute to a broader understanding of harbour porpoise in the Northeastern Pacific and provides further insight into the impact of anthropological disturbance in this highly trafficked area.

**Fecal glucocorticoid metabolite (FGM) analysis as a noninvasive tool to assess and monitor health in beluga whale (Delphinapterus leucas) populations**

Maureen Driscoll¹, Raina D’Orazio², Robert Suydam³, Caroline Goertz⁴, Tracy Romano¹
¹Mystic Aquarium, Mystic, CT, ²Cummings School of Veterinary Medicine, Tufts University, North Grafton, MA, ³North Slope Borough, Utqiagvik, AK, ⁴Alaska SeaLife Center, Seward, AK

Beluga whales are facing stressful environmental and anthropogenic challenges that are mediated by release of glucocorticoids (GC) into the bloodstream. Although the stress response is necessary and beneficial, continued GC release can have detrimental effects on behavior, immunity, and reproduction. GC are excreted with feces, making fecal GC metabolites (FGM) an ideal biomarker to quantify endocrine activity. In addition, a single FGM sample contains multiple hours of hormone accumulation, giving a more accurate estimation of hormone levels versus blood sampling. Fecal sampling is also completely noninvasive, thus providing opportunity for long-term monitoring needed for population health assessments.

In this study, a commercially available enzyme immunoassay (EIA) was validated for measuring FGM in belugas. Biological validation was carried out with aquarium belugas (n=2) to show FGM levels increase in response to an external challenge. A spike in FGM (15-60 ng/g) was observed within 4-7 h post-exam before returning to baseline (~10 ng/g) by 48 h. Longitudinal FGM analysis shows FGM is highest in Winter (74.82 ng/g) and lowest in Spring (28.14 ng/g). FGM analysis was further evaluated using samples collected from subsistence hunted belugas. Analysis revealed significant differences between sex, age, and reproductive class, with pregnant females having significantly higher FGM levels (94.55 ng/g) than adult males (14.18 ng/g). Notably, a pregnant beluga carrying a full-term fetus had the highest FGM concentration (131.19 ng/g). Additional samples from a rescued beluga calf from the endangered Cook Inlet population were used as a diagnostic
monitoring tool, and showed significant variation, with an average level of 21.83 ng/g. This study has demonstrated that this method will be useful to monitor wild beluga populations. Furthermore, because FGM analysis is completely noninvasive, it can be applied to endangered beluga populations such as Cook Inlet belugas to inform conservation strategies for the survival of the species.

Novel hemotropic mycoplasma detected in Amazonian and Bolivian river dolphins, Brazil

Aricia Duarte Benvenuto¹, Carlos Sacristán², Ana Carolin Ewbank¹, Roberta Zamana-Ramblas³, Irene Sacristán⁴, Waleska Gravena⁴, Daniela Mello⁵, Vera da Silva⁵, Miriam Marmontel¹, Vitor Carvalho Luz⁶, Juliana Marigo⁷, José Luiz Catao-Dias⁸

¹University of São Paulo, Brazil, ²University of Sao Paulo, BRAZIL, SAO PAULO, Brazil, ³School of Veterinary Medicine and Animal Sciences – University of São Paulo., São Paulo, São Paulo, Brazil, ⁴Centre for Animal Health Research (CISA), National Institute of Agricultural and Food Research and Technology (INIA), Valdeolmos, Madrid, Spain, ⁵Spanish National Research Council (CSIC), Madrid, Spain, São Paulo, São Paulo, Spain, ⁶National Institute of Amazonian Research, Manaus, Amazonas, Brazil, ⁷Instituto Nacional de Pesquisas da Amazônia - INPA, Manaus, Amazonas, AM, Brazil, ⁸Instituto Mamirauá, Tefé, Amazonas, Brazil, ⁹AQUASIS, Caucaia, Ceará, Brazil, ¹⁰School of Veterinary Medicine and Animal Sciences – University of São Paulo, São Paulo, SP, Brazil

Hemotropic mycoplasmas (hemoplasmas) are uncultivable, pleomorphic, small bacteria that infect mammals, including humans. Hemoplasmas are related to acute and chronic anemia, especially in immunodeficient hosts, capable of impairing individual survival. Despite descriptions in several wild species, little is known about its pathogenicity and transmission routes. We investigated the occurrence of *Mycoplasma* spp. in blood samples of live-captured Amazon (*Inia geoffrensis*, *n*=31) and Bolivian (*Inia boliviensis*, *n*=19) river dolphins of the Amazon basin, collected between 2015 and 2020 in Balbina hydroelectric dam, Tajapós river and Guaporé river. *Mycoplasma* DNA was detected in 32 out of 50 (64%) blood samples by conventional PCR targeting a 1400 pb fragment of 16S rRNA gene, suggesting high occurrence in this genus. Twenty-one (67.7%) and eleven (57.8%) of the tested Amazon and Bolivian river dolphins were positive, respectively. All retrieved nucleotide sequences presented less than 94.02% of identity with the closest sequence available on GenBank (*Candidatus* Mycoplasma haemolamae, Access number: CP003731.1), likely corresponding to a novel hemoplasma species herein proposed as *Candidatus* Mycoplasma haemoiniidae. The high detection rate suggests that the Amazon and Bolivian river dolphins are likely their natural hosts. Different sequence types were observed, related to species and collection site. To the author's knowledge, this is the first report of hemotropic mycoplasma in cetaceans worldwide. Our findings indicate that mammals with a fully aquatic life cycle are also infected by hemoplasmas, and shed light onto new - and still unexplored - epidemiological scenario for this infectious agent. Further studies are warranted to investigate the pathological relevance of hemoplasmas in cetaceans, especially in the *Inia* genus considering their conservation status and the numerous threats they are facing that could impair their immune status and predispose them to disease. We thank CNPQ for funding (Process number #141867/2019-8).
Net Loss: Will nations meet U.S. bycatch standards or face a U.S. import ban?
Zak Smith¹, Dianne DuBois², Francine Kershaw³, Kathleen O’Connell⁴, Alejandro Olivera⁵, DJ Schubert⁶, Sarah Uhlemann⁷
¹Natural Resources Defense Council, Bozeman, MT, ²Center for Biological Diversity, Asheville, NC, ³Natural Resources Defense Council, New York, New York, ⁴Animal Welfare Institute, Washington, DC, ⁵Center for Biological Diversity, La Paz, Mexico, ⁶Animal Welfare Institute, Egg Harbor Township, NJ, ⁷Center for Biological Diversity, Seattle, WA

Fisheries bycatch is the greatest threat to marine mammals on a global scale. More than 650,000 marine mammals are killed or seriously injured in commercial fisheries every year, and bycatch is threatening numerous iconic marine mammal species, including the vaquita and North Atlantic right whale with extinction. Reducing marine mammal bycatch in the world’s fisheries is therefore of key conservation and policy concern. In the United States, the vast majority of seafood consumed is imported. The U.S. has aggressive standards to limit marine mammal bycatch and attained almost a 30 percent reduction in domestic bycatch over a period of two decades. To reduce its international bycatch footprint, the U.S. issued a regulation under the Marine Mammal Protection Act (MMPA)—the MMPA Imports Rule—that bans seafood imports from nations whose fisheries kill or seriously injure marine mammals in excess of the United States’ own strong bycatch standards. The U.S. rule will be fully effective in 2023. The U.S. National Marine Fisheries Service, as the implementing agency, has identified more than 2,800 fisheries from more than 130 countries that must meet U.S. standards to continue exporting to the United States. To assess international compliance with U.S. bycatch standards, we assessed fisheries in several of these export nations in different regions around the world by evaluating bycatch, monitoring, and legal regimes. Our analysis concludes that several nations do not or may not meet U.S. standards. Reasons for non-compliance included a lack of monitoring of bycatch, a lack of a comparable regulatory regime, and a lack of enforcement. Our results underscore the necessity of the MMPA Imports Rule and affirm that the U.S. must ban imports of fish and fish products that do not meet U.S. standards.

SEMMACAPE: Monitoring and study of marine megafauna in wind farms by automatic characterisation
Gwénaël Duclos¹, Sebastien LEFEVRE², Sylvain MICHEL¹, Tristan ROUYER², Karine HEERAH³
¹WIPSEA, RENNES, France, ²Université Bretagne Sud - IRISA UMR 6074 OBELIX Team, VANNES, France, ³OFFICE FRANCAIS DE LA BIODIVERSITE, BREST, France, ⁴IFREMER, SETE, France, ⁵France Energies Marines, Plouzane, France

Project developers must produce environmental impact studies, particularly on marine megafauna (birds, mammals, turtles, big fish…). The analysis of the impacts of an offshore floating windfarm project requires aerial observations of marine megafauna in order to better characterise the frequentation of species in the proposed areas. This includes monitoring during the construction, operation and decommissioning phases, a total of about 30 years. These observations are classically based on aerial overflights by specialised naturalist observers. However, in the age of big data, recent scientific and technological developments offer new prospects for radically improving the cost-effectiveness of such monitoring. The SEMMACAPE project aims at demonstrating the ability of aerial photography processing and analysis software to automatically inventory marine megafauna. The project is built on a fully integrated scientific and technical content: 1) Aerial megafauna observation campaign (standard visual method and very high resolution digital photography system), integrating the
seasonal variability of species and environmental conditions; 2) Development and qualification of 2 types of automatic aerial photography processing algorithms for animal identification and classification: detection by deep neural (end-to-end) network, moving directly from the global image to bounding boxes; detection of anomalies by unsupervised deep learning; 3) Assessment of the performance of each detection method tested based on indicators classed by species or group of species, as well as according to environmental conditions. This project is led by the research unit IRISA (University of Bretagne Sud), with contributions from the WipSea company, France Energies Marines (institute for energy transition) and two public organisations: IFREMER and French Office for Biodiversity (OFB). Started in November 2019, this €600K project, partly funded by the French Agency for Energy Transition (ADEME), led to +100,000 high resolution imagery and first performance assessment results will be available to be presented at the end of 2022 S1.

**Contact Exchanges in Bottlenose Dolphin Mother-Calf Pairs**

**Savanna Duda¹, Kathleen Dudzinski², Manon Themelin³, Amy C. Hirons⁴**

¹Nova Southeastern University, ²Dolphin Communication Project, Port Saint Lucie, Florida, ³Dolphin Communication Project, Auvers Sur Oise, France, ⁴Nova Southeastern University, Dania Beach, FL

The relationship between a dolphin mother and her calf has been well studied, but details regarding specific tactile exchanges within these dyads are limited. Contact exchanged between four adult female bottlenose dolphins (Tursiops truncatus) and their calves was examined. From video collected in October 2018 and 2019, 134 contact events were documented in these dyads, with 122 contacts identified for initiator role. In 2018, Alita initiated most contact with her keel and Dory initiated most contact with her fluke. Tank, Bailey’s calf, initiated most contact (50%) with Bailey, who initiated only 36.4% of contacts. Tank initiated with his face and rostrum for over half these contacts. Five contacts were documented between Carmella and her son, Stan, with Carmella initiating three and Stan initiating two exchanges. No negative responses were documented by receivers for these mother-calf dyads; however, there were 30.4% (n=17) positive responses and 69.6% (n=39) neutral responses from receivers. In 2019, Dory initiated all but one contact with Alita, most heavily with her face and rostrum. Tank initiated 75% of the contacts with Bailey, who initiated 12.5% of the contacts. Tank lead half the time with his face. Sandy, Tilly’s calf, initiated most contact (80.5%) with Tilly. Tilly most often initiated with her keel or pectoral fin, while Sandy initiated with her dorsal fin most. Though they were observed together for 2.25 minutes, no contacts were documented between Carmella and Stan for 2019. For all pairs, no negative responses were documented; however there were 31.8% (n=21) positive responses and 68.2% (n=45) neutral responses from receivers. These results support that mother-calf dyads share much affiliative contact, with specific pairs exhibiting a potential preference for initiator role and contact type. Furthermore, these results strengthen understanding of mother-calf interactions and offer possibilities for evaluating contact exchanges in other dolphin dyads.

**Bottlenose Dolphin Calf Initiated Pectoral Fin Contact Exchanges with Mother, Other Kin, and Non-Kin**

**Kathleen Dudzinski¹, Christine A Ribic², Heather Hill³, Teri Bolton⁴**

¹Dolphin Communication Project, Port Saint Lucie, Florida, ²U.S. Geological Survey, Madison, Wisconsin, ³St. Mary’s University, San Antonio, Texas, ⁴Roatan Institute for Marine Sciences, Roatan, Bay Islands, Honduras

For dolphins, the strongest bond documented is
typically that between a mother and her pre-weaned offspring, but outside of the maternal relationship, our knowledge of calf behavior is limited. We examined how 23 bottlenose dolphin (*Tursiops truncatus*) calves (11 females and 12 males from 9 matrilines) initiated pectoral fin contact (PFC) exchanges with their mothers and kin ($n = 362$) versus with non-kin ($n = 950$). Calves initiated PFC exchanges with preferred partners (primarily their mothers) over individuals who were simply available to them. For calves with mothers as their only kin available, there was a difference in how they shared PFC with non-kin adults versus non-kin young. A calf was twice as likely to initiate PFC with an adult (mother or adult non-kin) as with another young dolphin. Male and female calves were different in how they initiated PFC with kin and non-kin, which supports previous research that identified a sex difference in calf behavior. These results support the observation that kin and non-kin dolphins share PFC differently. It is also likely that kin (mothers and calves, siblings, etc.) use other forms of contact to share information and potentially develop their relationships. Understanding all types of tactile contact would facilitate a more detailed understanding of how touch might be used by dolphins when relationships are established and maintained.

**Fresh Water Skin Disease: A Climate-Driven Emerging Disease of Coastal Dolphins**

Padraig Duignan¹, Nahiid Stephens², Kate Robb³

¹The Marine Mammal Center, Sausalito, California, ²Murdoch University, Perth, WA, Australia, ³Marine Mammal Foundation, Mentone, Victoria, Australia

A distinct ulcerative dermatitis known as *freshwater skin disease* is an emerging clinical and pathological presentation in coastal cetaceans worldwide characterized by often fatal epidermal ulceration that occurs following prolonged exposure to hyposaline water. In Australia, two remarkably similar mortality events enabled the creation of a case definition based on pathology and environmental factors. The first, in spring 2007, affected a community of endemic *Tursiops australis* in the Gippsland Lakes, Victoria, while the second, in spring 2009, occurred among *T. aduncus* resident in the Swan-Canning River system, Western Australia. The common features of both events were (1) an abrupt and marked decrease in salinity (from >30ppt to <5ppt) due to rainfall in the catchments, with hypo-salinity persisting weeks to months, and (2) dermatitis characterized grossly by patchy skin pallor that progressed to variable circular or targetoid, often raised, and centrally ulcerated lesions covering up to 70% of the body surface. The affected skin was often colonized by a variety of fungal, bacterial and algal species that imparted variable yellow, green or orange discoloration. Histologic lesions consisted of epidermal hydropic change leading to vesiculation and erosion; alternately, or in addition, the formation of intra-epithelial pustules resulting in ulceration and hypodermal necrosis. Thus, the environmental factors (natural or anthropogenic) and characteristic pathologic lesions, are necessary components of the case definition for freshwater skin disease. Recently (2019 and 2020), freshwater skin disease outbreaks in the northern Gulf of Mexico and south-eastern Australia have killed hundreds of coastal *Tursiops* sp. making this disease one of the most significant emerging threats to coastal dolphins.

**Using environmental parameters in feeding grounds to understand variations in humpback whale sighting frequency in Reunion Island**

Alexandre Modi¹, Vanessa Estrade², Emmanuel Cordier³, Audrey Jaeger⁴, Violaine Dulau²

¹GLOBICE, St-Denis, Reunion, ²GLOBICE-REUNION, Saint Pierre, Reunion, ³OSUR, Observatoire des Sciences de l'Université de la Réunion, St-Denis, France, ⁴Ecologie marine
Humpback whales typically undertake annual migrations from feeding areas in the higher latitudes to breeding areas in lower latitudes. Humpback whales breeding in the western Indian Ocean migrate from Antarctica but their main feeding areas and migration patterns remain largely unknown. In the last decade, variations in humpback whale occurrence within the western Indian Ocean breeding range have been observed, suggesting changes in migration behavior between years. Distribution surveys conducted over 16 years (2004-2020) in Reunion Island indicated significant variations in sighting frequency between years, in consistency with observations at other breeding sites. In order to better understand the factors that might influence humpback whale occurrence in Reunion, several environmental parameters were downloaded from remote sensing data available in their potential Antarctic feeding areas (sea surface temperature, chlorophyll a concentration, sea-ice coverage). Index of Southern annular mode was also obtained. For each variable, the mean value was calculated between December and March at different time-lags (6, 18 and 30 months) and within 3 main areas, from 0° to 90° of longitude (i.e. 0°-30°, 30°-60° and 60°-90°) off Antarctica. A smaller region, that encompass Prydz Bay was also investigated. Linear regression models were used to assess the effect of environmental features on humpback whales sighting frequency. Results revealed a significant and positive influence of sea surface temperature with a time-lag of 6 months and a significant positive effect of chlorophyll a with a time-lag of 30-months for the 0-90° area. SST and chlorophyll a concentration may have an impact on biological maturation of krill at different time scale affecting abundance of food resources for humpback whales. This study provides a first approach to link environmental parameters in potential feeding areas of humpback whales to their occurrence in a western Indian Ocean breeding area.

Environmental factors are known to influence the abundance and distribution of marine zooplankton; however, knowledge on how oceanographic patterns impact nearshore fine-scale prey aggregations is limited. The Pacific Coast Feeding Group (PCFG) of gray whales are generalist feeders but have demonstrated selection preference for patches consisting of calorically rich Neomysis rayii mysid shrimp off the coast of Oregon, USA. We hypothesize that local oceanographic conditions (e.g., temperature, turbidity, dissolved oxygen, currents) and benthic structures (e.g., rocks and reefs) influence the availability of prey for gray whales, and thus impact the PCFG foraging ecology and response to environmental perturbations. To address this hypothesis, we characterize oceanographic conditions and their relative influence on prey patch distribution and gray whale foraging patterns near Port Orford, Oregon, USA. During the same four-week summer period in five consecutive years (2016-2021) we conducted fine-scale tracking of gray whale behavior and movements using a theodolite (250 gray whale tracklines) and simultaneously collected prey species availability at 12 replicate stations through GoPro drops (n>970) and net tows (n>750) from a research kayak. Spatial analysis of Mantel tests and ordinations will be used to assess the role of dissolved oxygen, temperature, turbidity, depth,
distance from headlands, local topography, and benthic structure on prey distribution. Community trajectory analysis (CTA) will also be performed to assess prey patch composition across habitat (eg. rocky reef with vs without kelp). Ecosystem shifts due to climate change pose an increasing threat, and could impact prey distribution patterns, which should be closely monitored to provide adaptive management of the PCFG population. Our research will inform management decisions concerning this small, culturally distinct sub-group by identifying environmental patterns that influence the distribution and availability of their calorically rich prey.

Systematic analysis of injuries sustained by entangled rorqual whales off the U.S East Coast
Paulette Durazo1, Jooke Robbins2, Maria Harvey3, Emily Kelly2, Bob Lynch, David Mattila4, Michelle Silva2, Scott Landry3
1Center for Coastal Studies, North Truro, MA, 2Center for Coastal Studies, Provincetown, Massachusetts, 3Center for Coastal Studies, Provincetown, MA, 4International Whaling Commission and Center for Coastal Studies

Entanglement in fishing gear is a documented source of anthropogenic impact on baleen whales. However, the frequency of events can be challenging to assess. Fewer than 10% of humpback whale entanglements are thought to be witnessed in progress, even off the U.S. East Coast where entanglement awareness and response is well developed. A scar-based method was developed to reliably detect prior entanglement events among humpback whales, but the necessary feature (the caudal peduncle/fluke insertion) is not routinely documented in all populations, nor routinely visible in other species. Here, we describe a systematic analysis of injuries on rorquals witnessed carrying gear off the U.S. East Coast and reported to the Atlantic Large Whale Disentanglement Network. Over 1,362 images from 259 entanglement cases were assessed for the nature and severity of injuries. Cases primarily involved live humpback whales (n=215), but also included fin (n=13), minke (n=29) and sei whales (n=2). In total, 6,015 body areas were coded for image quality, injury presence/absence and injury severity. Additionally, longitudinal research on humpback and fin whales bounded the possible entanglement duration and revealed changes in entanglement-related injuries over time. This work is expected to improve understanding of the frequency and impact of entanglement of rorquals in the U.S., and will facilitate scar-based studies of entanglement over a range of species and populations worldwide.

Real-time passive acoustic monitoring from gliders triggers dynamic management restrictions that protect North Atlantic right whales
Delphine Durette-Morin1, Kimberley Davies2, Christopher Taggart3, Veronique Nolet4
1Dalhousie University, 2University of New Brunswick, Saint John, New Brunswick, 3Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, 4Transport Canada

The North Atlantic right whale (NARW; Eubalaena glacialis) faces a population decline and high mortality rates due to vessel strikes and entanglements in fishing gear in the Gulf of St. Lawrence (GSL), Canada. The federal Canadian government institutions responsible for fisheries, oceans resources and ocean transportation have implemented spatial dynamic fishery-area closures and vessel speed restriction zones to mitigate the risk of entanglements and vessel strikes to North Atlantic right whales (NARW) in the GSL. In 2020, near-real time passive acoustic monitoring of NARW from underwater gliders was used for the first time to trigger both dynamic fishery and vessel restrictions in
Canada, yet these management plans differ in their objectives, scopes and scales. We present a performance study wherein glider survey plans were designed for two deployments of Slocum gliders, each equipped with a digital acoustic monitoring instrument (DMON). One glider was deployed to support the fisheries management and the other to support the shipping management. Each glider survey plan was optimized to fit the objectives and scales of their respective dynamic management plan. The pilot deployments took place between 17 Jul - 26 Aug in the NARW habitat in the southern GSL, and between 17 Aug - 15 Nov in the Laurentian Channel Dynamic Shipping Zone C, respectively. The southern GSL glider detected NARWs on 20 days and triggered 8 fishery area closures, and the Laurentian Channel glider detected NARWs on 7 days and triggered a 10-knot speed restriction for 34 days. The results of this study show how gliders can be applied as monitoring tools to support dynamic management of NARW under a variety of management scenarios.


Miranda Dziobak1, Randall Wells2, Brian Balmer3, Emily Pisarski4, Ed Wirth5, Leslie Hart6

1University of South Carolina, 2Chicago Zoological Society’s Sarasota Dolphin Research Program, Sarasota, Florida, 3National Marine Mammal Foundation, Johns Island, SC, 4CSS under contract to NOAA, Charleston, SC, 5NOAA, 331 Fort Johnson Rd, SC, 6College of Charleston, Charleston, South Carolina

Phthalates are a class of endocrine-disrupting chemicals added to plastics, personal care products, and cleaning solutions. Pervasive use and propensity to leach from products to which they are added have resulted in marine phthalate contamination, raising concerns for wildlife health. Detectable urinary phthalate metabolite concentrations can indicate exposure to parent compounds, which previous studies have demonstrated is prevalent among common bottlenose dolphins (Tursiops truncatus) in Sarasota Bay, Florida. This study characterized di(2-ethylhexyl) phthalate (DEHP) exposure by examining demographic and spatiotemporal differences among Sarasota Bay resident dolphins (2010-2019; n=69). Additionally, potential impacts on endocrine function were investigated via correlational analyses between phthalate metabolite concentrations and serum hormone levels. Approximately 75% of sampled individuals had detectable concentrations of at least one phthalate metabolite, and mono(2-ethylhexyl) phthalate (MEHP) was the most frequently detected (n=28; GM=4.57ng/mL; 95% CI=2.37-8.80). Urinary geometric mean (GM) concentrations of MEHP did not vary in magnitude (females: GM=6.60ng/mL; 95% CI=2.92-14.95; males: GM=2.36 ng/mL; 95% CI=0.73-7.64; juveniles: GM=3.14ng/mL; 95% CI=1.27-7.77; adults: GM=5.81ng/mL; 95% CI=2.21-15.28) or in the frequency of detection by sex or age class (females= 60.00%; male=47.62%; adult= 50.00%; juveniles= 64.71%; p>0.05). Conversely, DEHP exposure may have been influenced spatiotemporally. Detectable MEHP concentrations were significantly higher in 2014 and 2015 (GM=33.71ng/mL; 95% CI=10.43-54.41) than in sampling years prior (2010-2013: GM=1.37ng/mL; 95% CI=0.056-17.43; p=0.0065) and following this time period (2016-2019: GM=2.33 ng/mL; 95% CI=0.97-2.79; p=0.0012). Similarly, ranging patterns differed between dolphins with detectable MEHP concentrations and unexposed dolphins, revealing a potential relationship with urban land use. While health impacts from exposure are not yet understood for dolphins, our findings suggest a correlation between MEHP and free T4 among adult females (Kendall’s tau=0.47, p=0.0071). To our knowledge, this is the first study characterizing DEHP exposure in free-ranging...
cetaceans, providing critical context for understanding potential sources and health risks.

Cook Inlet Beluga Strandings Pre- and Post-listing under the U.S. Endangered Species Act

Bonnie Easley-Appleyard¹, Barbara Mahoney², Kim Shelden¹, Mandy Keogh¹, Kate Savage⁵
¹NOAA, Anchorage, AK, ²Alaska Regional Office, NMFS, NOAA, Anchorage, AK, ³Alaska Fisheries Science Center, Seattle, Washington, ⁴NOAA Alaska Region, Juneau, AK, ⁵NOAA Fisheries Juneau Protected Resources Office, Juneau, AK

Belugas (Delphinapterus leucas) reside year-round in the waters of Cook Inlet, Alaska. The population has declined by nearly 79 percent since 1979, from about 1,300 whales to an estimated 279 whales in 2018. Initially a steep population decline was documented from 1994-1998 during a period of high harvests. However, the population failed to recover despite harvest regulations and Cook Inlet belugas were listed as endangered under the U.S. Endangered Species Act (ESA) in 2008. Cook Inlet beluga strandings primarily occur along tidal mudflats in upper Cook Inlet, and range from individuals to mass strandings of more than 100 whales. Strandings include beached and floating carcasses, as well as live belugas found in waters too shallow to swim until the next high tide. Live strandings may occur for a number of reasons including failure to move to deeper waters during extreme tidal fluctuations (30+ ft.), when escaping predators or other threats, because of illness, or when pursuing prey in river channels. The earliest stranding record for this population in the Alaska Marine Mammal Stranding Network database was reported in 1983. The number of reported beluga strandings fluctuate annually and almost all reports occurred during the ice-free period from late April to early November. Responding to each stranded beluga provides an opportunity to obtain data on individual health, natural history, and evidence of human interactions; as well as long term monitoring of the population.

Data on reported Cook Inlet beluga strandings were assessed to evaluate potential spatial and temporal differences pre- and post-listing under the ESA.

Effectiveness of Using Unmanned Aerial Systems (UAS) to Assess Manatee Aggregations at Warm-Water Sites

Kerri Scolardi¹, Sheri Barton², Jennifer Johnson³, Kristin Eaton³
¹Mote Marine Laboratory, Sarasota, Florida, ²Mote Marine Laboratory, Sarasota, FL, ³Mote Marine Laboratory, Sarasota

Florida manatees (Trichechus manatus latirostris) are limited in their tolerance to cold; thus, in winter months, large numbers of manatees aggregate at coastal power plants, providing wildlife managers the opportunity to assess trends in abundance and distribution through manned aerial surveys. Aerial surveys have long been considered an economical means by which to produce a long-term database for the threatened manatee, but the risk associated with conducting low-altitude maneuvers remains a concern. The use of Unmanned Aerial Systems (UAS) for assessing wildlife populations has grown significantly in recent years, and studies to date suggest that drones provide a low-cost, safe alternative to traditional methods. In 2018, Mote Marine Laboratory (MML), in collaboration with Florida Power & Light Company (FPL), initiated a proof of concept study to assess the efficacy of using UAS for obtaining counts and documenting the distribution of manatees at winter sites in comparison with concurrent conventional aerial surveys. Counts of manatees were recorded by an aerial observer in a high-winged Cessna 172 aircraft flown at an altitude and air speed of 700 ft and 90 kt, respectively. A DJI quadcopter, flown at an altitude of 300-400 ft, flew a predetermined route of the same study area, stopping to hover briefly (< 1 minute) over large groups of manatees (>20). UAS videos were later analyzed by both experienced (n=1) and
inexperienced (n=1-5) manatee surveyors to determine abundance and distribution of manatees. Three concurrent surveys were conducted at 2 study sites for a total of 6 surveys over 2 winter seasons. The UAS produced high quality video from which counts and distribution of manatees could be determined, regardless of water clarity conditions, with no evidence of animal response to the drone. Analysis of manual counts thus far indicates level of surveyor experience does effect counts from video reviews.

Urban dolphins of Baja: The distribution pattern of inshore bottlenose dolphins in the urbanized coastal seascape of La Paz Bay, BCS, Mexico
Addy Echevarria¹, María Alejandra Esteves Ponte², Manuel Gonzalez³, Lenin Enrique Oviedo Correa⁴
¹National University of Costa Rica, San Jose, San Jose, Costa Rica, ²Centro Interdisciplinario de Ciencias Marinas CICIMAR del Politécnico Nacional, Mexico, La Paz, Baja California Sur, Mexico, ³Deep Baja, La Paz, BCS, Mexico, ⁴Laboratorio de Ecología de Mamíferos Marinos Tropicales - Centro de investigación de Cetáceos Costa Rica CEIC, Rincon de Osa, Costa Rica

Urbanization of the inshore/coastal seascape has increasingly become an important anthropogenic impact for many inshore coastal species, such as the inshore ecotype bottlenose dolphin (Tursiops truncatus), due to the residency pattern of many wild populations that finds suitable habitats in inshore habitats, also favored by human settlements exploiting inshore/coastal resources. Bottlenose dolphins are part of the conspicuous marine megafauna in La Paz Bay BCS, Mexico (LPB hereafter), with a population size of fewer than 80 individuals (CI: 70-90). This delphinid shares most of the local coastline with a human population of over 250,000 inhabitants. This study explored the distribution pattern, contrasting the occurrence of inshore bottlenose dolphins to environmental factors that might shape the local habitat use. An ongoing assessment of population size and demography of resident bottlenose dolphins in LPB yields data on spatiotemporal habitat use and occurrence. We analyzed sightings ‘location collected in 2021 (n=58), comparing qualitatively these dolphins’ locations with the distribution of four variables (Depth, Temperature, Turbidity, and Chlorophyll concentration). We produced interpolation maps through QGIS software (open access QGIS 3.20.1), through the Inverse Distance Weighted procedure. We documented sightings of bottlenose dolphins on 81% of all 68 surveys in 2021. The temporal distribution of the dolphins’ sightings favors spring (100%) and summer (100%), whereas occurrence diminished considerably during autumn (37.5%) with a slight increase in winter (63%). Dolphins’ presence favors the deeper portion of the entire habitat (depths < 7 m), especially groups with mothers and calves observed during foraging. Likewise, the presence of dolphins coincides in areas of high chlorophyll concentration associated with the mangrove-lined shoreline in the inner part of the Bay. Dolphins are top-predators in these shallow estuarine habitats, and due to their dependence on the coastal resources for foraging, and calves’ protection, they are key bioindicators of habitat health in LPB.

Revolutionizing Behavioral Sampling of Cetaceans with Unoccupied Aerial Systems (UAS): A Literature Review and Case Study
Mary Edmondson, Duke University

Unoccupied aircraft systems (UAS, aka drones) have revolutionized how researchers sample cetacean behavior by improving the accuracy and detection of cetacean behaviors. Despite this advancement, only 16 published studies to date utilize drones to study cetacean behavior. A review of 1,657 behavioral studies published from 1980 to 2020 reveal that 39 species lack any direct behavioral research, and the majority of studies do not leverage key methodical and
technological advances within the field, which can reduce observational biases. Ninety-six percent (96%) of studies lacked critical information about observations, protocols, and observed behaviors, and it was uncommon for studies to explicitly address biases and limitations within their research. The most favored sampling methods used were ad libitum (29%) and continuous sampling (22%) methods, which are often non-systematic and arduous for observers. The case study demonstrated that UAS can be used as a tool for researchers to accurately capture bubble-net foraging observations of humpback whales (*Megaptera novaeangliae*) while reducing disturbance and observational bias arising from traditional observational methods. Recommendations to improve accuracy and reduce bias in behavioral studies are provided to help address shortcomings revealed by the present study.

**Monitoring Abundance of Aggregated Animals (Florida Manatees) Using an Unmanned Aerial System (UAS)**

**Holly Edwards**¹, Jeffrey Hostetler², Bradley Stith³, Julien Martin⁴

¹Florida Fish and Wildlife Conservation Commission, Saint Petersburg, FL, ²United States Fish and Wildlife Service, Laurel, MD, ³Gainesville, Florida, ⁴USGS, Wetland and Aquatic Research Center, Gainesville, FL

Imperfect detection is an important problem when counting wildlife, but new technologies such as unmanned aerial systems (UAS) can help address this problem. We used data collected by a multirotor UAS during four surveys at 16 sites and a Bayesian closed capture-mark-recapture model to estimate abundance and distribution while accounting for imperfect detection of aggregated Florida manatees (*Trichechus manatus latirostris*) at thermal refuges to assess use of current and new warmwater sources in winter. Our UAS hovered for 10 mins and recorded 4K video over sites in Collier County, FL. Open source software was used to create recapture histories for 10- and 6-min time periods. Mean estimates of probability of detection for 1-min intervals at each canal varied by survey and ranged between 0.05–0.92. Overall, detection probability for sites varied between 0.62–1.00 across surveys and length of video (6 and 10 mins). Abundance varied by survey and location, and estimates indicated that distribution changed over time, with use of the novel source of warmwater increasing over time. The highest cumulative estimate occurred in the coldest winter, 2018 (N = 158 CI = 141-190). Methods here reduced survey costs, increased observer safety and allowed us to obtain rigorous abundance estimates at a difficult to monitor aggregation site.

**Growth in South American Pinniped Whiskers: Calibrating Nature’s Data Loggers**

**Mickie Edwards**¹, Susana Cárdenas-Alayza², Maria Jose Ganoza³, Michael Adkesson⁴, Amy C. Hirons¹

¹Nova Southeastern University, Dania Beach, FL, ²Universidad Peruana Cayetano Heredia, Lima, Lima, Peru, ³Programa Punta San Juan, Universidad Peruana Cayetano Heredia, Lima, Peru, ⁴Chicago Zoological Society, Brookfield, IL

Pinniped vibrissae (whiskers) are continuously growing, inert, keratinous tissues. As whiskers are composed of organic and inorganic elements acquired via an individual’s diet, they make ideal recorders of their foraging environments and ecologic signals. To best correlate time (days, months, years) along the whiskers, ¹⁵N-labelled glycine (98% δ¹⁵N microbiological/pyrogen tested) was administered to two otariid pinniped species, South American fur seal *Arctocephalus australis* (SAFS) and South American sea lion *Otaria byronia* (ASAL), under human care at Parque Zoológico Huachipa in Peru; this label created an artificial marker of known date incorporating along the growing whiskers. Two
doses of a labeled glycine (5mg glycine/kg body weight), each dose 6 months apart (October, March), were fed to one adult female SAFS and two SASL (one subadult male and one adult female) via their diet. The adult female fur seal had a growth rate of 0.08-0.15 mm/day, while the adult female sea lion vibrissae had a growth rate of 0.09-0.16 mm/day. The subadult male sea lion had a growth rate of 0.08-0.15 mm/day. The more rapid growth rate corresponds to the months of pupping, reproduction, and molting, ie. a period of increased metabolic rate (October-December, SAFS; December-February, SASL). Therefore, a static growth rate cannot be applied across an annum. Species-specific vibrissae growth rates are essential to interpret not only trophic fluctuations recorded within the whiskers, but also the timing of ecologically important events, such cyclic El Niño-Southern Oscillation cycles, in which wild members of these species reside.

Uncovering northern bottlenose whale (Hyperoodon ampullatus) patterned clicks: insights into beaked whale communication?
Ana Eguiguren1, Laura Feyrer2, Joy Stanistreet3, Hilary Moors-Murphy4, Wilfried A. M. Beslin4, Hal Whitehead5
1Dalhousie University, Quito, Ecuador, 2Fisheries and Oceans Canada, 3Fisheries and Oceans Canada, Dartmouth, Nova Scotia, 4Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, 5Department of Biology, Dalhousie University, Halifax

Northern bottlenose whales (Hyperoodon ampullatus, NBW), found in the deep and cold waters of the North Atlantic, are among the most social beaked whale species. They are typically observed in groups and, while females form short-lived associations, males form bonds that can last up to 2 years. Still, much of their social behavior remains unknown. Most research on NBW vocalizations has focused on the echolocation clicks they produce for echolocation while foraging; how individuals of this species communicate remains undetermined. Recently, the presence of ‘doublet click trains’—pairs of clicks with short inter-click intervals (ICIs) separated by long ICIs – produced by NBW has been described, suggesting a possible mode of social communication. Here, we studied the presence of click patterns by analyzing recordings collected within 30 minutes of visual encounters with NBW at the surface on the Scotian Slope and off Newfoundland (Canada). Recordings were made using a towed 2-element hydrophone array between 2015 – 2019. Click patterns were defined as sets of consecutive clicks (< 10) separated by ICIs < 1 second from each other. NBW clicks were present in 63.19% of 163 recordings (23.33 hrs). We confirmed the presence of ‘doublet click trains’ and ‘triplets’ – 3-click patterns – in 3.97% and 5.56 % of files where NBW clicks were present, respectively. We detected 5 doublet click trains, in which long ICIs (µ=1.57s, sd=0.98) were on average 3.17 (sd=1.18) times longer than short ICIs (µ=0.43s, sd=0.15). We detected 12 triplets for which both ICIs were similar (µ=0.43s, sd=0.11; µ2nd-to-1st-ICI ratio, sd=0.09). The presence of temporally patterned clicks in NBW vocalizations provides a promising avenue to study NBW social communication. Furthermore, If NBW click patterns are socially learned, the geographical distribution of click pattern dialects could reveal socially mediated population structure.

Variation in male reproductive success in a singing cetacean
Franca Eichenberger1, Emma Carroll2, Claire Garrigue1, Luke Rendell1, Debbie Steel1, Claire Bonneville6, Simon Jarman7, Ellen Garland8
1University of St Andrews, St Andrews, Fife, United Kingdom, 2University of Auckland, Auckland, New Zealand, 3UMR ENTROPIE Institute of Research for Development, Noumea, New Caledonia, 4St Andrews, United Kingdom, 5Queen’s University, Belfast, Northern Ireland, 6Wildlife Department and Marine
Assessing the variation in reproductive success — the fundamental prerequisite for sexual selection to act upon a trait — is crucial in understanding a species’ mating system and population growth. Parentage analyses in cetaceans are rare, and the underlying forces of sexual selection acting on their mating behaviours, including elaborate acoustic displays, remain poorly understood. Here, we combined 22 years of photo-identification and genetic data to assess variation in male reproductive success and population recovery of an endangered humpback whale breeding population located in New Caledonia, in the South Pacific. Paternity analysis of 179 known mother-offspring pairs and 948 adult males revealed low variation in male reproductive success with an average of 1.18 offspring per father over the entire study period. Observed male skew was higher than expected under random mating (FET: p = 0.01) but low relative to other polygynous species, including other aquatically-mating mammals. Differences in male reproductive success were further explored by assigning ages derived from the humpback epigenetic age assay to understand whether age was a factor in male reproductive success. Finally, the male breeding population was preliminarily estimated to consist of 2,266 [95% CI: 1898, 2636] males and showed a growth rate of 1.53% [95% CI: -0.45, 3.56] over the study period. The observed low reproductive skew is in line with findings of other humpback whale populations and further emphasizes the discrepancy of genetic estimates of paternity and predictions of the proposed polygynous social mating system in this species. Alternative mating tactics and/or female choice may counterbalance within-sex variation in reproductive success and should be considered when investigating the factors affecting male reproductive success and the underlying function(s) of humpback whale song.

Diffusion modeling reveals effects of multiple release sites and human activity on a recolonizing apex predator

Joe Eisaguirre1, Perry Williams2, Xinyi Lu3, Michelle Kissling4, William Beatty5, George Esslinger6, Jamie N Womble7, Mevin Hooten8

Reintroducing predators is a promising conservation tool to help remedy human-caused ecosystem changes. However, the growth and spread of a reintroduced population is a spatiotemporal process that is driven by a suite of factors, such as habitat change, human activity, and prey availability. Sea otters (Enhydra lutris) are apex predators of nearshore marine ecosystems that had declined nearly to extinction across much of their range by the early 20th century. In Southeast Alaska, which is comprised of a diverse matrix of nearshore habitat and managed areas, reintroduction of 413 individuals in the late 1960s initiated the growth and spread of a population that now exceeds 25,000. Periodic aerial surveys in the region provide a time series of spatially-explicit data to investigate factors influencing this successful and ongoing recovery. We integrated an ecological diffusion model that accounted for spatially-variable motility and density-dependent population growth, as well as multiple population epicenters, into a Bayesian hierarchical framework to help understand the factors influencing the success of this recovery. Our results indicated that sea otters exhibited higher residence time as well as greater equilibrium
abundance in Glacier Bay, which is protected as a national park, as well as areas closed to commercial fishing. Asymptotic spread rates suggested sea otters colonized Southeast Alaska at rates of 1-8 km/yr with lower rates occurring in areas correlated with higher residence time, which primarily included areas near shore and closed to commercial fishing. Further, we found that the intrinsic growth rate of sea otters may be higher than previous estimates suggested. This study shows how predator recolonization can occur from multiple population epicenters. Additionally, our results suggest spatial heterogeneity in the physical environment as well as human activity and management can influence recolonization processes, both in terms of movement (or motility) and density dependence.

Multi-scale analysis of killer whale habitat use in Icelandic waters
Ayça Eleman1, Niall McGinty2, Chiara Giulia Bertulli3, Guðmundur Óskarsson4, Snæbjörn Pálsson5, Filipa Samarra6
1University of Iceland, Ankara, Turkey, 2Mount Allison University, Llanarth, Ceredigion, United Kingdom, 3Sea Watch Foundation, 4Marine and Freshwater Research Institute, Reykjavik, Iceland, 5Faculty of Life and Environmental Sciences, University of Iceland, Iceland, 6University of Iceland, Vestmannaeyjar, Iceland

Killer whales, the ocean’s apex predators, are considered to be generalists as a species, but can exhibit strict diet specialisation at the population level. This has important implications during fluctuations of their principal prey. In Iceland, herring appears to constitute a major part of the diet of the killer whales, however this is an unpredictable prey that can undergo dramatic changes in availability and distribution. At present, the extent of killer whale specialisation on herring is unknown. To advance our understanding of the occurrence and consequences of predator dietary specialisation in a changing environment this study aims to investigate the habitat use of killer whales and how it is affected by variation in prey abundance and distribution. This will be tested using a combination of observational data, on predator and prey, and modelling approaches at two different scales. Firstly, a multi-model ensemble forecasting approach (BIOMOD) will be used to investigate the relationship between the distribution of killer whales in Icelandic waters with respect to environmental variables (e.g. depth, slope, sea surface temperature, chlorophyll a concentration, and distance to the shore), as well as prey and modelled zooplankton abundance and distribution to predict areas of high suitability for this species. Secondly, fine-scale habitat use and patterns of occurrence of individual killer whales and groups will be examined at herring spawning grounds in Vestmannaeyjar, south Iceland, by using occupancy models. A long-term killer whale photo-identification dataset will be used in combination with data on herring abundance in Icelandic waters, in situ prey measurements from the study area, and environmental variables. The findings of this study will create new insights on predator-prey dynamics and their drivers and consequences of dietary specialisation in marine top predators. These findings will also serve as input for ecosystem-based management decisions, supporting both conservation and fishery needs.

Governance of Cetacean Bycatch in Regional Fisheries Management Organizations: progress, gaps, and looking ahead
Brianna Elliott1, Marguerite Tarzia2, Andy Read3
1Duke University, 2International Whaling Commission, Impington, United Kingdom, 3Duke University, Beaufort, North Carolina

Bycatch is the leading global threat to cetaceans, with at least 300,000 cetaceans estimated to be killed each year in fisheries. Regional fisheries
management organizations (RFMOs) are instrumental actors in global fisheries management, but their role in cetacean bycatch management is often overlooked and they have yet to reach their potential to adopt effective monitoring and mitigation measures for cetacean bycatch. Given these gaps, we conducted a semi-quantitative review of 16 RFMOs worldwide to understand how each organization addresses bycatch of cetaceans in their fisheries. We developed twenty-five scoring elements to evaluate each RFMO with respect to best practices in cetacean bycatch management, grouped into five categories: 1) general bycatch governance; 2) observer coverage; 3) quantitative bycatch limits; 4) data analysis and transparency; and 5) mitigation efforts. The specific scores were shared with the RFMOs for their input in refining the scores. Collectively, RFMOs scored highest in “data analysis and transparency” (average=0.64, SD=±31) and lowest in “quantitative bycatch limits” (average=0.16, SD=±29) with considerable variation across RFMOs. Overall, this scoring highlights that RFMOs have passed few binding conservation and management measures (CMMs) focused on cetacean bycatch, particularly compared to other taxa of marine megafauna, such as seabirds and sea turtles; the few existing measures are primarily focused on bycatch in purse seines. Only one RFMO has passed a CMM on gillnets, the gear type responsible for most cetacean mortality. We provide recommendations to the RFMO community on improving governance of cetacean bycatch and highlight the recent adoption of the 2021 FAO Technical Guidelines on Marine Mammal Bycatch to support progress on this critical issue at RFMO negotiations.

Coastal cetaceans are often discontinuously distributed through their range and face threats from anthropogenic activities in the nearshore environment. Long-term studies of coastal dolphin distribution and habitat use at local scales, in addition to the effects of natural catastrophes, have important implications for species management and marine spatial planning. The Hector’s dolphin (Cephalorhynchus hectori) is a small delphinid endemic to the coastal waters of South Island New Zealand and exhibits high levels of geographic and genetic population structure. In November 2016, a 7.8 Mw earthquake struck the Kaikōura district, causing major disruption to the coastal environment. Sightings of Hector’s dolphins from boat-based surveys conducted over an eight-year period (2013 - 2020) spanning the 2016 Kaikōura earthquake, were used to analyse spatio-temporal variations in patterns of distribution during the austral summer using Generalized Linear Models. Species distribution models were then fitted using Generalised Additive Models to analyse environmental covariates of distribution over the same time period. This study demonstrates that Hector’s dolphins along the Kaikōura coastline have a patchy distribution with distinct areas of high occurrence at Haumuri Bluffs and the Hapuku River mouth, situated between areas of relatively low use. Recent patterns of distribution were similar to those observed before the Kaikōura earthquake, indicating long-term consistency in habitat use over an 8-year period. Important environmental predictors of Hector’s dolphin distribution were water depth, sea surface temperature, percentage sand in bottom substrate, and distance to river mouth. The quantification of local distribution patterns and environmental characteristics of important areas of habitat are pertinent for the management of Hector’s
dolphins along the Kaikōura coastline and provide important insights into the resilience of local populations to habitat disturbance events.

**Assimilation Takes Time: Social Integration of a Social Cluster of Spotted Dolphins (Stenella frontalis) After a Large Immigration Event in 2013**

Cindy Elliser¹, Denise Herzing², Cassandra Volker³

¹Pacific Mammal Research, Anacortes, Washington, ²Wild Dolphin Project and Florida Atlantic University, Dept of Biological Sciences, ³Wild Dolphin Project, Boynton Beach, FL

In 2013, a resident community of 52 spotted dolphins (Stenella frontalis) from Little Bahama Bank (LBB) embarked on an unprecedented exodus and relocated 161 km south to Great Bahama Bank (GBB). GBB was already home to a resident community of spotted dolphins, thus providing a unique opportunity to study if and how the two communities would integrate. Previous analyses from 2013-2015 showed very little interaction between the community of dolphins that moved to GBB and the resident community. However, current analyses have shown that since 2015 there has been significant integration between these two communities. Coefficients of association (CoA) using the half-weight index were calculated using SOCPROG 2.9 for individuals sighted 4 or more times per pooled periods, 2015-2017 and 2018-2020. Associations were nonrandom and the overall mean CoA was 0.17 and 0.21 respectively. Similar to previous analyses on LBB and GBB communities, Mantel tests showed that within age and sex associations were stronger than between, with higher male-male associations than any other sex class combination. Male alliances (with CoA up to 4-5 times the community average) were present between LBB males, GBB males and LBB/GBB males. Hierarchical agglomerative cluster analysis revealed three social clusters: two that were comprised of LBB and GBB animals, and one that only had GBB animals. Mantel tests revealed that associations within clusters were stronger than between; but also that associations within residency status (LBB individuals vs. GBB individuals) were stronger than between, indicating that there is still preferential association within the original communities, despite obvious integration. Assimilation takes time, and while new relationships are being made, old ones remain that may continue to influence the social re-structuring of this new community over time. This emphasizes the importance of social flexibility for long-term survival during and after upheaval events.

**25 years of growth - a comparison of the numbers and behaviour of humpback whales using the BSB2 mid-latitude feeding ground off southern Africa 1993 to 2018.**

Simon Elwen¹, Tess Gridley², Bridget James³

¹Stellenbosch University, Cape Town, South Africa, ²University of Cape Town, Cape Town, Western Cape, South Africa, ³Stellenbosch University, South Africa

Humpback whales aggregate in tightly knit ‘supergroups’ of tens to hundreds of individuals to feed in the nutrient rich Benguela Ecosystem off South Africa. A 1993 study used a combined shore-based and small-boat survey during three weeks in Oct-Nov (Best et al. 1995) to investigate whale feeding behaviour. In that study, 62 sightings of 155 humpback whales were made from shore and 68 groups of 117 right whales. Boat surveys over 1112km identified 12 groups of 27 whales (photographically identified as 10 individuals). In 2018, we conducted a 3-week survey from the same lighthouse with boat-based surveys of a similar area. Methods were adapted to a scan sampling approach to account for high whale numbers. Every ten minutes we attempted to obtain a location fix of all groups within view, and group size and behaviour. Shore based surveys on ten days resulted in 174 scans
of 0 to 156 humpback whales (mean = 41.9 individuals) conservatively estimated within view. Feeding behaviour could last all day (07h00 to 16h00 on one occasion with never less than 40 individuals in view) with groups constantly splitting and joining. In contrast to the earlier study, only 3 southern right whales were seen on 2 days. Boat surveys (5 days, 394 km) identified 18 groups of humpback whales (group size: 1 to 50, mean = 7) and with 7 groups of 1 to 3 right whales observed. Photo-ID confirmed multiple matches of individuals between days and years, confirming the temporary residence and high site fidelity of animals to this feeding ground. Results provide insight into the significant growth of this population, the nature and extent of feeding behaviour and the need to consider this behaviour in all management plans for the southern Benguela from shipping routes to aquaculture and fisheries models.

Anthropogenic threats to endangered Southern Resident killer whales in U.S. coastal waters
Candice Emmons1, Bradley Hanson2, Marc Lammers3
1NOAA Northwest Fisheries Science Center, Seattle, Washington, 2Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, 3Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, Hawaii

As part of an effort to examine year round movements of endangered Southern resident killer whales (SRKW), autonomous passive acoustic recorders were deployed at multiple sites spanning the Washington, Oregon, and California coasts from 2011-2017. These recorders also provided near year-round monitoring of anthropogenic sound sources and insight into the potential threats to SRKW outside the Salish Sea. Mid frequency active sonar (MFA) and explosive sounds were both detected. MFA events were rare (n=148) and occurred in every month of the year, with the majority of events occurring between February and May when SRKW are most frequently detected. While these overlap temporally, MFA events were only detected on 1% of days at nearshore sites where SRKW are most frequently detected. During the study period, 3152 explosive sounds were detected on 466 days. The percent of days monitored at each site with explosive sounds ranged from less than 1% to 19%. Less than five explosive sounds were heard on most of these days, but there were eight days with 100 or more of these sounds. They were detected in every month of the year peaking in the summer months when SRKW are more commonly sighted in the Salish Sea. Despite this regular occurrence in inland waters, SRKW were detected on the outer coast in each summer month. While explosive sounds were not attributed source, the acoustic characteristics of these sounds were similar to those of small explosives such as seal bombs. The proximity of the majority of these sounds to areas of high fishing intensity and a lack of correlation with reported activity by the U.S. Navy provide additional evidence that the majority of these sounds are small explosives associated with fishing activity. These data provide critical information on the potential risks to SRKW throughout their range.

Going up the country – detailed tag data provides critical insight into a North Atlantic right whale’s seventeen-day journey north
Daniel Engelhaupt1, Amy Engelhaupt2, Jessica Aschettino1, Mark Cotter3, Joel Bell4
1HDR Inc., Virginia Beach, Virginia, 2Amy Engelhaupt Consulting, Virginia Beach, Virginia, 3UMass Dartmouth, Virginia Beach, VA, 4Naval Facilities Engineering Systems Command Atlantic, Norfolk, Virginia

With fewer than 400 individuals remaining, critically endangered North Atlantic right whales...
(NARW) face the threat of extinction within our lifetime without the implementation of robust and meaningful protection measures. While much is known about NARWs on the northeastern U.S. and Canadian feeding grounds and the southeastern U.S. calving grounds, little is known about movement and behavior of whales occurring in the western Mid-Atlantic. On 03 March 2021, during a multi-year U.S. Navy-funded survey effort to provide a more detailed assessment of baleen whale species occurrence, diversity, and habitat use over the continental shelf, a single NARW (identified as a yearling born February 2020) was sighted 73 km southeast of Virginia Beach, Virginia in approximately 30 m of water. A Wildlife Computers SPLASH10-F-333 dive/location LIMPET-configured tag designed to collect medium-scale movements and dive behavior and a D3 DTAG recording fine-scale dive/movement/acoustics data were simultaneously deployed. Over the 17-day LIMPET tag duration this young whale remained over the continental shelf with the majority of locations close (< 15 km) to shore, navigated three major sets of high-traffic shipping lanes, and ultimately travelled over 1,000 km to the north until the last tag location was recorded 15 km east of Boston, Massachusetts. A combined total of 4,500 dives and surfacing events was recorded. Mean dive depth was 19.3 m, mean dive duration was 6.0 min, and mean surfacing event duration was 3.1 min. The dataset collected from the LIMPET tag is believed to be the longest near-continuous dive/surfacing record for a NARW to date. Multi-day movement and dive behavior collected on NARWs located in poorly understood areas provides the scientific community, regulators, and stakeholders with critical data required to make bold decisions to save a species teetering on the brink of extinction.

Assessment of the usage of Marine mammals’ body parts in fetish practices: A case study of African Manatees (Trichechus senegalensis) hunted around coastal communities of southern Nigeria.

Edem Eniang¹, Nyimale Alawa², Unyime Akpan³, Ime Utit⁴, Inemesit Eniang³
¹BIODIVERSITY PRESERVATION CENTER (BPC), Uyo, Akwa Ibom, Nigeria, ²RIVERS STATE UNIVERSITY, PORT HARCOURT, Nigeria, ³Biodiversity Preservation Center, Uyo, Akwa Ibom, Nigeria, ⁴Department of Fisheries and Aquatic Environmental Management, Uyo, Akwa Ibom state, Nigeria

The usage of African manatees’ body-parts in fetish practices is becoming burning issue in biodiversity conservation in Nigeria, with numerous reports indicating widespread killing of manatees by hunters/fisher-folks from poorest coastal communities who depend mainly on components of fisheries and wildlife as major sources of animal protein compared to elsewhere in large cities. We collected data from 20 villages of 4 Nigerian states, from 2010 to 2020, to investigate the use of Manatee body-parts in fetish practices of local trado-medical care givers/ Juju Diviners and their beneficiaries for analysis towards future conservation management. Also, spatial information on hunting/fisheries bycatch from 10 manatee hunters and 55 fishermen, combined with 120 beneficiaries, provided understanding of coastal community involvements and socio-economic factors influencing those activities. Whilst several species were used in trade, manatee’s male organ was found popularly used as local aphrodisiac for men and their inner ear bones predominantly used to make bracelets that ward-off bullets from the wearer locally called ‘Akpuub’. A manatee yields 2 bracelets, therefore, escalating Terrorism and insurgency in north-east, banditry and cattle-rustling across northern-savannas, armed Fulani-herdsmen invasions/ kidnapping in south-west and middle-belts as well as militancy in Niger-Delta coupled
with general insecurity across Nigeria is perceived to be strongly related to increasing number of manatees killed. Although the use of charms/products were common, beneficiaries regarded it as sacrilegious to admit publicly, thus, a significant proportion of trade/consumption may not have been documented. Investigation of commodity chain characteristics from seashores to riversides/consumers, revealed that some law enforcement agents and criminals have used one product or another. The trend which is dangerous to manatee’s survival is influenced by changes in socio-economic status of people and underscores need for policies/law enforcement in Nigeria which requires greater understanding of both socio-economic drivers and illegal traders in manatees.

Yawn-like behavior in a captive dugong, Dugong dugon
Akiko Enokizu¹, Tadamichi Morisaka², Yukari Handa², Motoi Yoshioka³
¹Mie university, Japan, ²Cetacean Research Center, Mie university, Tsu, Mie prefecture, Japan, ³Mie University, Tsu, Mie, Japan

Yawning is defined as an involuntary action that starts by slow gaping with inhalation until maximum opening of the mouth and ends quickly with closure of the mouth and exhalation. Yawning has been observed in various vertebrates, implying that yawning is an evolutionarily conserved behavior. We previously reported yawn-like behavior in captive common bottlenose dolphins, Tursiops truncatus, as the first underwater yawning report of fully aquatic mammals. The yawn-like behavior in dolphins has a similar action pattern to yawning in humans, and occurs during resting, suggesting that the yawn-like behavior in dolphins is yawning without any breath. Here, we report yawn-like behavior in a captive dugong, which is a marine mammal that has adapted to underwater life independently of cetaceans. Observations were conducted for six days (a total of 20.1 h) on a captive female dugong (estimated age: 35 years) in Toba Aquarium, Japan. We recorded 14 cases of yawn-like behavior. The average duration of the behavior was 4.85 ± 1.00 s. Ten of the 14 cases occurred when the dugong stopped moving at the bottom and middle of the tank. The remaining four cases occurred during swimming or moving at the bottom of the tank. The yawn-like behavior thus occurred mainly during a state of immobility or resting. Yawning is found in various mammals during resting on land (e.g., monkeys, lions, South American sea lion). The dugong exhibits yawn-like behavior in the resting state, similar to yawning in other mammals. Therefore, yawn-like behavior in the dugong is also considered to be yawning. The yawn-like behavior in a dugong provides further evidence of yawning without breathing in marine mammals.

Acute and Chronic HPA Axis Stimulation Alters White Blood Cell Ratios but Not Inflammatory Markers or Oxidative Stress in Elephant Seals
David Ensminger¹, Daniel Crocker², Emily Lam³, Kaitlin Allen⁴, Jose Pablo Vazquez-Medina⁵
¹San José State University, Concord, CA, ²Sonoma State University, Rohnert Park, CA, ³UC Berkeley, Corte Madera, CA, ⁴University of California Berkeley, Oakland, California, ⁵University of California, Berkeley, Berkeley, California

The hypothalamic-pituitary-adrenal (HPA) axis controls the release of glucocorticoids, which regulate immune and inflammatory function by modulating cytokines, white blood cells (WBCs), and oxidative stress via glucocorticoid receptor (GR) signaling. Although the response to HPA activation is well characterized in many species, little is known about the impacts of HPA activation during extreme physiological conditions in marine mammals. Hence, we
challenged 18 simultaneously fasting and developing elephant seal pups with daily intramuscular injections of adrenocorticotropic (ACTH), a GR antagonist (RU486), or a combination (ACTH+RU486) for four days (4d). We collected blood at baseline, two hours (2h), and 4d after the beginning of treatment. ACTH and ACTH+RU486 elevated serum aldosterone and cortisol at 2h, with effects diminishing at 4d. RU486 alone induced a compensatory increase in aldosterone, but not cortisol, at 4d. ACTH decreased neutrophils at 2h while decreasing lymphocytes and increasing neutrophil:lymphocyte ratio at 4d. These effects were abolished by RU486. Despite alterations in WBCs, there was no effect of ACTH or RU486 on transforming growth factor-β or interleukin-6 levels; however, both cytokines decreased with the 4-d fasting progression. Similarly, ACTH did not impact protein oxidation, lipid peroxidation, or antioxidant enzymes, but plasma isoprostanes and catalase activity decreased while glutathione peroxidase increased with fasting progression. These data demonstrate differential acute (2h) and chronic (4d) modulatory effects of HPA activation on WBCs and that the chronic effect is mediated, at least in part, by GR. These results also underscore elephant seals’ resistance to potential oxidative stress derived from repeated HPA activation.

The social and behavioural context of humpback whale calls on a North Atlantic foraging ground
Mikala Epp1, Gail Davoren2, Cory Matthews3
1University of Manitoba, 2University of Manitoba, Winnipeg, Manitoba, 3Fisheries and Oceans Canada, Winnipeg, Manitoba

Humpback whales (Megaptera novaeangliae) produce a variety of call types, some of which are shared among populations in different ocean basins, while others appear to be unique to a particular region or behaviour. Despite increasing efforts to describe call types and context, there is still much unknown about the function of humpback whale calls. The goal of this study was to examine how humpback whale call use differs among behavioural and social contexts on a foraging ground off Newfoundland, Canada. We quantified whale behaviour using scan, focal group, and ad libitum sampling, which was paired with simultaneous hydrophone recordings over a five week period during the summer of 2021, when humpback whales were foraging on seasonal capelin aggregations. Observed behaviours included foraging, milling, and traveling. Pairs and trios of whales were most often seen, but larger groups were also observed. Calls from recordings are being classified according to the existing repertoire for the region, along with reference to descriptions from other regions, with many of the previously described call types for the region being observed. Variation in call type with behavior (e.g., foraging, resting) and context (e.g., group size, group membership) is being quantified using generalized linear models to determine whether certain call types or call features are associated with certain contexts. Findings will advance scientific theories regarding cetacean communication, as well as aid in understanding how environmental changes could impact the communication system of humpback whales. Additionally, knowledge of how calls are used could increase the effectiveness of passive acoustic monitoring to examine humpback whale activity within a given area.

Seasonal movements of the Amazon river dolphins between várzea habitats detected through passive acoustics
Florence Erbs1, Marina Gaona1, Mike van der Schaar2, Emiliano Ramalho3, Dorian Houser4, Michel Andre5
1Laboratory of Applied Bioacoustics, Technical University of Catalonia, BarcelonaTech (UPC), Vilanova i la Geltru, Barcelona, Spain, 2UPC, Vilanova i la Geltru, Spain, 3Instituto de Desenvolvimento Sustentável Mamirauá, Tefé,
River dolphins are under increasing levels of cumulative human pressures that threaten their survival. There is a critical need to develop cost-efficient tools to monitor population movements and habitat preference in order to identify key areas for conservation. The endangered Amazon river dolphins, the boto (*Inia geoffrensis*) and the tucuxi (*Sotalia fluviatilis*) inhabit the intricate freshwater systems of the Amazon basin. The boto particularly takes advantage of the seasonally flooded areas (‘várzea’) to penetrate the forest, with adult females and calves especially dependant on this habitat. Here, using passive acoustic monitoring (PAM), we monitored the seasonal movements of the river dolphins from main rivers to the critical várzea habitat in the Mamirauá Reserve in Brazil. We used convolutional neural networks (CNN) to automatically process two years of data collected from five different sites representing main boto habitat types: entrance to the main river, várzea channel, and low várzea forest and lakes. The classifier was trained to identify sound classes including echolocation clicks and boats using an active learning procedure. Final performance was high with an average precision of 0.97 and 0.83 respectively. Results of the classification showed two main peaks of acoustic activity, corresponding to the movements of the dolphins inside and outside the várzea. Additionally, the dolphins were acoustically detected on all three flooded forest sites, suggesting a wide dispersion of the boto inside this large area. To the best of our knowledge, this is the first PAM report of the boto movements inside the flooded forest, which is very difficult to survey through traditional methods. The use of PAM and most recent advances in classification methods are providing a better understanding of the boto dependence upon várzea habitats, a fundamental aspect for improving the conservation strategies of this species.

**Relevance of severe macro-epibiont growth on the skin of Florida manatees (Trichechus manatus latirostris)**

Nicola Erdsack¹, Athena Rycyk², Jessica Skinner³, Tyrone Ryba³, John E. Reynolds¹

¹Mote Marine Laboratory, Sarasota, Florida, ²New College of Florida, Sarasota, Florida, ³University of Florida, Gainesville, Florida

Florida manatees have rich epibiont communities on their skin. Their skin serves as a substrate for micro and macro fouling organisms and ectoparasites, including toxic cyanobacteria, fungi, algae, and invertebrates, including several crustacean and nematode species. The epibiont cover can be dense enough to resemble a fur-like coating. Amount and composition of biofouling differ considerably between individuals, occasionally even between mother and calf. Besides differences due to environmental factors, such as salinity and solar radiation, severe epibiont growth may be a symptom of a weakened immune system, which in turn would increase the manatee’s susceptibility to diseases and other threats, such as cold stress and red tide poisoning. In a first approach to investigate potential coherences between intense biofouling and serious illness in Florida manatees, we developed a classification system to quantify manatee skin macro-epibionts and used it to analyze carcass photographs from FWC’s necropsy database over a ten-year period. We tested for relations between amount of growth and causes of death, such as cold stress syndrome and red tide poisoning. Although we did not find general relations between macro-epibiont cover and cause of death, correlations with certain causes of death within specific age groups were found. Furthermore, we could confirm correlations between amount of growth and salinity, and time.
of year. This study presents a first approach in
the effort to identify causes and effects of severe
macro-epibiont growth on the skin of individual
manatees and its potential to serve as an indicator
for underlying health issues in a manatee.

Estimating Cetacean Population Trends from
Static Acoustic Monitoring Data through
Paired Year Ratio Assessment (PYRA)
Grist Eric PM¹, TJ McKinley¹, Saptarshi Das¹,
Tom Tregenza¹, Aileen Jeffries², Nick Tregenza¹
¹University of Exeter, Exeter, United Kingdom,
²Harbor Porpoise Project, Anacortes,
Washington, ³Chelonia Limited, Mousehole,
Cornwall, United Kingdom

The cetacean conservationist is often faced with
evaluating population trends from abundancy
data that are either sparse or recorded at different
times within different years. This means that the
presence of seasonal or diel patterns in the data
together with unplanned gaps are frequently a
source of difficulty. While sophisticated
statistical approaches such as generalized
additive modelling (GAM) may assist, they do so
at the cost of demanding additional complexity
and are easily misinterpreted by non-expert
statisticians. We aim to provide a simple and
transparent non-parametric trend evaluation
approach based on year-on-year comparisons of
observations whenever they are possible. Our
methodology is developed to address the problem
of estimating population trends from incomplete
data. Such data are typical of those obtained by
static acoustic monitoring of cetaceans at logger
sites particularly those near the species range
margins. We refer to our approach as Paired Year
Ratio Assessment (PYRA). We compare its
performance with trend estimation using GAM
and nonparametric randomisation tests requiring
a greater level of skill and experience for proper
application.

Standardization of heart rate, respiration
rate, and body surface temperature values for
West Indian manatees (Trichechus manatus)
under human care
Sylma Maria Escobar-Torres¹, Antonio
Mignucci², Carla Ivette Rivera-Perez³, Roberto
Sanchez Okrucky⁴
¹Inter-American University of Puerto
Rico/Puerto Rico Manatee Conservation Center,
Puerto Rico, ²Manatee Conservation Center,
Bayamón, Puerto Rico, ³Ross University School
of Veterinary Medicine, San Juan, Puerto Rico,
⁴Grupo Dolphin Discovery, Cancun, Quintana
Roo, Mexico

In veterinary medicine, the first step in
diagnosing a patient's condition is to obtain their
vital signs, including heart rate (HR), respiratory
rate (RR), and body temperature (BT). Marine
mammals are no different, including threatened
and endangered manatees. Recognizing and
reporting these vital signs can make a difference
in the patient's health and immediate attention.
To establish average vital signs for West Indian
manatees (Trichechus manatus), including both
subspecies, the HR, RR, and surface BT of 26
adults, sub-adult, and calves under human care in
Mexico and Puerto Rico were taken during the
study period. All of these individuals were in
stable condition at the time of sampling. The
methods of monitoring the vital signs were non-
invasive, except for HR, which involved direct
hand contact for 30 seconds. The average HR
was 61.9±5.9 bpm (n=160, normal range 56-68
bpm), the average RR was 3.2±1.5 breaths / 5
min, (n=160, normal range 1 to 5 breaths / 5min),
and the average surface BT was 28.5±2.2ºC
(n=160, normal range 26.3-30.7ºC).
Standardizing species' typical behaviors and vital
signs aids in recognizing when something may
be amiss or when an animal's condition may
destabilize. At the same time, it is essential to
know these standard vital signs at the time of
rescues to correctly assess the animal patient’s
condition correctly. It is recommended that all
facilities monitor these easily obtained
parameters and recognize their immediate intervention variability when warranted.

On Valuing Nature-Based Solutions to Climate Change: A Framework with Application to Whales

Sonia Espanol1, Ralph Chami2, Thomas Cosimano3, Connel Fullenkamp4, Fabio Berzaghi5, José Palazzo5, Milton Marcondes6

1MERI Foundation, Santiago, Chile, 2International Monetary Fund, 3Duke University, 4University of Tuscia and Université Bourgogne Franche-Comté, 5Instituto Baleia Jubarte, 6Instituto Baleia Jubarte, Caravelas, Bahia, Brazil

We developed a framework for natural resource valuation that directly addresses the fundamental collective action problem in environmental protection. Our framework uses the lessons of behavioral economics to create values that individual decisionmakers find credible and relatable, in addition to stimulating excitement or concern that is essential to prompting action. We then apply this framework to value blue whales that are found off the coasts of Chile. The values we estimate for individual members of these species are significant: an average of $4 million per whale. We discuss how our valuations lead to new designs for environmental preservation and restoration policies.

Temporal and Spatial Dynamics of the Baleen Whale Community in New York Bight

Bobbi Estabrook7, Danielle Harris2, Kristin Hodge1, Daniel Salisbury1, Ashik Rahaman1, Julia Zeh1, Meghan Rickard3, Susan E Parks6, Aaron N. Rice7

1Cornell University, 2Centre for Research into Ecological and Environmental Modelling, University of St Andrews, St Andrews, United Kingdom, 3Center for Conservation Bioacoustics, Cornell Lab of Ornithology, Ithaca, NY, 4Syracuse University, 5New York Natural Heritage Program; New York State Department of Environmental Conservation, Mount Sinai, NY, 6Syracuse University, Syracuse, New York, 7Cornell University, Ithaca, NY

New York Bight (NYB) is an ecologically important marine region along the U.S. Atlantic Exclusive Economic Zone. Despite its economic and environmental value to New York State (NYS) and the United States, relatively little is known about the occurrence of large whales in this area. To provide detailed information on the spatial and temporal presence of whale species in NYB, we conducted a continuous passive acoustic survey at 14 sites between October 2017 and October 2020 (1095 days). Sensors were deployed across two transect lines along the Nantucket-Ambrose and the Ambrose-Hudson Traffic Separation Schemes. The focal species were North Atlantic right whales (Eubalaena glacialis), humpback whales (Megaptera novaeangliae), fin whales (Balaenoptera physalus), sei whales (B. borealis), and blue whales (B. musculus), each of which, apart from the Gulf of Maine stock of humpback whales, are listed as endangered under the U.S. Endangered Species Act. These passive acoustic data provide insight into the temporal and spatial presence of these five whale species over the 3-year period. Right whales and humpback whales were detected during all months of the year. Right whales exhibited strong seasonality, with peak presence during fall months. Sei whales were detected primarily during spring and winter months. Fin whales were detected on at least 30% of days in each month and exhibited slight seasonality. Blue whales were the rarest of the species, with detections only during a small portion of fall and winter days. Humpback and right whale spatial presence varied across NYB by season, while sei, blue, and fin whale spatial presence mainly occurred closer to the outer continental shelf edge. Considering conservation efforts and increasing human use of NYB, the extensive and dynamic spatiotemporal presence...
of these whale species observed across all three years highlights the potential for these data to inform adaptive or actionable management.

**Abundance estimation of the pantropical spotted dolphin (Stenella attenuate) around Reunion Island using distance sampling**

Vanessa Estrade¹, Violaine Dulau¹

¹GLOBICE-REUNION, Saint Pierre, Reunion

Reunion island is a French territory located in the southwest Indian Ocean. Its waters host 23 species of cetaceans. Among them, the pantropical spotted dolphin, *Stenella attenuata*, is the most frequently encountered species in oceanic waters (encounter rate= 0.009 sighting per hour). This species is part of the Least Concern species of the IUCN Red List but abundance estimate of this oceanic species is lacking for most areas. This study reports the first population abundance estimate of pantropical spotted dolphins around the oceanic island of Reunion using distance sampling method. Boat-based line-transect surveys were conducted around the island until 12 nautical miles offshore between 2009 and 2019 (totaling 41 days and 3952 km of effort). In total, 29 groups (1399 individuals) of pantropical spotted dolphins were recorded in the 7701 km² survey area. The species mostly occurs over the insular slope, at a mean bottom depth of 1300 (± 400) meters and at a mean distance of 13.5 (± 5.7) kilometers from the coastline. The best fitted detection functions were a “uniform+cosinus” (AIC=314.42) and a “half-normal without adjustment terms” (AIC=314.57) models. These two models yielded a density estimate of 0.57 ± 0.17 individuals per km² and 0.57 ± 0.19 individuals per km², which, extrapolated to the survey area, resulted in abundance estimate of 4364 individuals (± 1346, 95%CI=2411-7899) and 4405 individuals (± 1438, 95%CI=2455-8243) respectively. This study provides baseline data to assess the local conservation status of the species and may constitute a starting point for future work to monitor this population dynamics, which is essential to plan conservation management.

**Sex-dependent vertical transmission of socio-ecological strategies in bottlenose dolphins (Tursiops aduncus)**

Taylor Evans¹, Vivienne Foroughirad², Ewa Krzyszczyk¹, Molly McEntee¹, Céline Frère³, Janet Mann⁴

¹Georgetown university, WASHINGTON, DISTRICT OF COLUMBIA, ²Georgetown University, MOREHEAD CITY, North Carolina, ³University of the Sunshine Coast, Sippy Downs, Queensland, Australia, ⁴Georgetown University, Washington, DC

Individual socio-ecological strategies reflect the long-term persistence and covariance of social and ecological traits, emphasizing the multiple factors driving individual behavioral variation. In bottlenose dolphins for example, highly gregarious individuals tend to spend less time foraging and use less specialized foraging tactics compared to less social, tool-using individuals. Such social and ecological variation has a demonstrable impact on population structure and responses to environmental variation. However, it is not known how this variation is maintained within populations. Vertical transmission of behaviors from mother to offspring is prevalent, and may be particularly pertinent for long-lived mammals with extensive maternal care and ample opportunity for social learning, such as primates and delphinids. Although foraging tactics appear to be vertically transmitted, whether this is true for multifaceted socio-ecological strategies is unknown. We utilized 32 years of behavioral and demographic data collected on wild Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) to investigate the strength of maternal behavioral effects on individual socio-ecological strategies. We categorized the adult socio-ecological strategies of 125 (73 female, 52 male) individuals, along
with their mother’s strategy, based on gregariousness, habitat use, and foraging tactics. Maternal socio-ecological strategy was a strong predictor of offspring strategy, especially for females. For some strategies involving specialized foraging tactics, fidelity from mother to daughter was nearly 100%. For males however, the strength of maternal effects was more variable. We hypothesize that an interaction between the sex-bias in maternal effects and socio-ecological strategies mediates fitness consequences. Sex differences in life history pressures likely dictate how advantageous a particular socio-ecological strategy is, so the benefit of mirroring maternal socio-ecology varies by both sex and specific strategy. This is a rare empirical study of the connection between maternal effects and socio-ecological strategies.

Exploring variability in North Atlantic right whale calling behaviour in eastern Canadian soundscapes
Clair Evers¹, Jinshan Xu², Hilary Moors-Murphy³, Delphine Durette-Morin⁴
¹Fisheries and Oceans Canada, Halifax, ²Fisheries and Oceans Canada, ³Fisheries and Oceans Canada, Dartmouth, Nova Scotia, ⁴Dalhousie University

The North Atlantic right whale (NARW) is a migratory species that travels between winter calving grounds in the United States to summer feeding grounds in Canada. Passive acoustic monitoring (PAM) recorders have detected NARW across a diverse range of habitats in Canada, from coastal basins designated as critical habitat to deep-water submarine canyons on the shelf edge. The soundscapes that whales are exposed to can vary considerably across these different habitats, and previous studies have shown that noise can impact NARW calling behaviour over both short and long-time scales. This study aims to explore variation in NARW calling behaviour with ambient noise levels using PAM data collected from multiple bottom-mounted recorders in eastern Canadian waters between 2015-2019. We used an automated detector to detect NARW upcalls (commonly used to assess NARW presence) on the recordings. All detections were manually verified as upcalls by an analyst. Upcall occurrence and characteristics (e.g., frequency and received levels) were measured and compared across locations and years. Ambient noise levels were then measured before and after each upcall and potential correlations between call characteristics and noise levels were investigated. Preliminary analysis of recordings from one coastal location, Emerald Basin, identified 477 upcalls between 2015-2017. The received levels of these upcalls varied by 20db and increased with increasing noise levels. There was no correlation between upcall frequency and noise. Very few upcalls were detected in Emerald Basin during 2018-2019 compared to previous years and we are exploring reasons for this variability in occurrence. Detection range modelling for each location and year, and identification of soundscape contributors, both anthropogenic (e.g., shipping and seismic airguns) and environmental (e.g., wind and precipitation) are underway. Overall, results will allow us to better understand the effects of noise on NARW calling behaviour.

Preliminary Visual Assessment of Body Condition and Skin Lesions in the Endangered Rice's Whale (Balaenoptera ricei) from the Gulf of Mexico
Ruth Ewing¹, Debra Abercrombie², Amy Brossard³, JOSUE DIAZ DELGADO⁴, Joy S. Reidenberg, Ph.D.⁵, Anthony Martinez⁶, Lance Garrison⁷
¹NOAA, National Marine Fisheries Service, Miami, FL, ²CIMAS/UM, NOAA/SEFSC, ³Cooperative Institute of Marine Atmospheric Studies, NOAA SEFSC MMFD Affiliate, Big Pine Key, FL, ⁴COLLEGE STATION, ⁵Icahn School of Medicine at Mount Sinai, New York, New York, ⁶Southeast Fisheries Science Center, NOAA
The Rice’s whale (*Balaenoptera ricei*), is a newly recognized endangered Balaenopterid whale and is the only resident baleen whale in the northern Gulf of Mexico. Field observations of these animals have indicated apparent variability in body condition (BC) and the presence of skin lesions of unknown types. We developed and applied protocols to measure BC, assess changes over time, and rate skin lesion occurrence and trends in Rice’s whales based upon a historical catalog of photo-identified individuals. Opportunistic photographs (*n* = 2759) obtained during vessel surveys conducted from 2004-2019, were reviewed for 33 uniquely identifiable individuals. Defined standards for scoring BC condition and skin lesions were developed, tested for consistency and reproducibility between multiple evaluators and applied systematically. BC assessment based on descriptive morphological features visible at the temporalis, post-nuchal region, ribs, scapula and vertebral spinous processes, and epaxial musculature. Visible external skin lesions were scored based on comprehensive descriptors (number, distribution, extent, shape, size, variability, color, texture, margins, and consistency) and likely etiopathogenic interpretations were recorded. Visual assessment revealed body condition heterogeneity among individuals. Skin nodules and presumed cookie-cutter shark bite wounds prevailed over other lesions. Preliminary results indicate: 1) decreased BC for three potential mother-calf pairs photographed over five sightings, two of which were re-sighted with a different calf; 2) variation of BC over time from which worsening was evident for some individuals; 3) increase of nodules, of unknown etiology, in most whales between early and later years; 4) increased records of healed presumptive cookie-cutter shark bite wounds (*Isistius* sp.); 5) an individual with trauma to the dorsal peduncle consistent with an injury due to a vessel strike; 6) and whales with possible evidence of past entanglement. These findings provide baseline data for health assessment of this population and have important implications for conservation and recovery planning.

**Utilization of photo-identification data to assess serious injury in bottlenose dolphins (*Tursiops truncatus*) along the east coast of Florida**

**Agatha Fabry¹, Teresa Jablonski¹, Wendy Nokie-Durden²**

¹Hubbs-SeaWorld Research Institute, ²Hubbs-Sea World Research Institute, Melbourne Beach, FL

The inherent risks present in common bottlenose dolphin (*Tursiops truncatus*) communities may drive sociality, behavior and habitat utilization. Likewise, estimating the impact of anthropogenic activities on dolphin communities is critical to conservation efforts. Understanding how both natural risk (predation) and anthropogenic factors (entanglement, vessel interactions) correspond with serious injuries and mortality is pertinent to management efforts. The objectives of this study were to utilize images from photo-identification surveys (2008-2018) in estuarine waters along the east coast of Florida (Halifax River, Mosquito Lagoon) to evaluate the rate of injury (shark predation, anthropogenic causes, unknown causes) in bottlenose dolphins. Identifiable dolphins (all age classes) within the study area were assessed for serious injury. In total, 51% of individuals exhibited injuries or scars consistent with prior trauma. Shark bites and scars were common and were observed in 36% of animals, whereas 9% of animals bore scars from anthropogenic injuries, and 10% presented serious injury of unknown origin. Results reflect a minimal estimate of injuries in this community as much of the animal is often not visible during surfacing (primarily the ventral aspect). Since human interactions are prevalent in this region and the central study area (Ponce Inlet) is known to be a hotspot for shark attacks on humans, it is not surprising that dolphins utilizing the area
commonly exhibit injuries from both sources. As the human population continues to grow and environmental conditions continue to shift, it is likely that dolphin populations will navigate increased risk in the future.

Assessing the impact of giant salvinia invasion on the African manatee distribution in Lake Ossa and determining the most efficient manatee detection method

Clinton Factheu¹, Athena Rycyk², Eric Angel Ramos³, mumi kikuchi⁴, Beth Brady⁵, Aristide Takoukam Kamla⁶, Lucy Keith-Diagne⁶, Sévilor Kekeunou⁶

¹University of Yaounde 1, Yaounde, Center Region, Cameroon, ²New College of Florida, Sarasota, Florida, ³The Graduate Center, City University of New York, BROOKLYN, NY, ⁴Japan manatee education and study lab, chuo-ku, tokyo, Japan, ⁵Mote Marine Aquarium, POMPANO BEACH, FL, ⁶African Marine Mammal Conservation, Dizangue, -- Select --, Cameroon

The African manatee is the least studied sirenian and large mammal in Africa. Due to their cryptic nature, African manatees are difficult to monitor through traditional visual methods. Lake Ossa, a manatee sanctuary in Cameroon, is being invaded by giant salvinia, an aquatic fern which has covered over 50% of the lake’s surface and has the potential to outcompete the manatee’s main food source, the antelope grass. This may influence how manatees are distributed in Lake Ossa. In this study, we aimed to: 1) Determine and compare manatee occurrence frequencies in invaded and non-invaded areas of Lake Ossa; 2) Determine and compare the detection rates of three manatee detection methods. From November 2020 to October 2021, we conducted monthly simultaneous visual point-scans, 360-sonar scans and passive acoustic recordings of vocalizations at ten sites in Lake Ossa (five sites in the invaded and five in the non-invaded area). Manatee occurrence frequencies were calculated as the ratio between the number of successful scans and the total number of scans. Methods’ detection rates were calculated similarly. We used Pearson’s Chi-square tests to ascertain differences in manatee occurrence frequencies and methods’ detection rates. There was a statistically significant difference (p=0.03) between the occurrence frequencies of manatees in the salvinia-invaded (21.67%, n = 60) and the non-invaded area (41.67%, n = 60). Methods’ detection rates also differed significantly (p<0.01) and passive acoustics exhibited the greatest detection rate (24.17%, n = 120) followed by the 360-sonar (11.67%, n = 120) and the visual point scan (3.33%, n = 120). This study shows that Giant Salvinia influences the manatee distribution in Lake Ossa and that acoustic technologies can help to better detect the elusive African manatee. Results of this project will inform manatee conservation actions in Lake Ossa and shape African manatee detection methods in future surveys.

Maternal Foraging Behavior and Habitat Use Affects Mercury Exposure of Endangered Steller Sea Lions

Brian Fadely¹, Michelle Lander², Brian Taras³, Todd O’Hara⁴, Lorrie Rea⁵

¹NMFS/AFSC Marine Mammal Laboratory, Seattle, Washington, ²Marine Mammal Laboratory, AFSC, NOAA Fisheries, Seattle, Washington, ³Alaska Department of Fish and Game, Juneau, AK, ⁴University of Alaska Fairbanks, Fairbanks, AK, ⁵Univeristy of Alaska Fairbanks, Fairbanks, Alaska

Steller sea lion (Eumetopias jubatus, SSL) pups of the western/central Aleutian Islands are exposed to mercury (THg) in utero at levels of health concern with potential for population-level effects. Mercury content of SSL prey varies within and among species, in part due to geographic location, with maternal foraging ecology an unknown factor affecting fetal exposure. We investigated total mercury concentrations ([THg]) measured in hair and
blood of 13 adult female (AF) SSLs captured in autumn of 2011-2015 relative to diving behaviors and habitat use inferred from the first 16 days of post-deployment telemetry data and recent (summer-autumn) and older (previous winter) diets estimated from C and N stable isotope analysis of vibrissa. Seven AFs were considered high risk with hair [THg] above toxicological thresholds of effect (20 ppm), whereas six females were lower to moderate risk. Blood [THg] was significantly related to six dive indices, and hair [THg] was greater in AFs with shallower average dive depths suggesting recent foraging behavior was influential. Higher risk SSLs tended to spend more time on the shelf and remained closer to shore than low-mod risk SSLs, and winter δ¹⁵N displayed a marginal, negative relationship with average distance from shore. There was no relationship between proportions of prey species in the fall diet of females and was independent of diving behavior categorized as on-shelf, off-shelf or both, or benthic and epipelagic. Neither hair nor blood [THg] was correlated with whisker δ¹⁵N reflecting recent diet, suggesting trophic feeding level was not a major driver of [THg] accumulation in AFs. Body condition was unrelated to foraging strategies or [THg], suggesting that while individual strategies may be successful, they expose dams to varying [THg] with potential health consequences to their offspring.

Ecological Implications of Multi-Day Behavioral Synchrony and Physiological Variation in a Blue Whale Pair

James Fahlbusch¹, Max Czapanskiy², William Oestreich³, John Calambokidis⁴, William Gough⁵, Jeremy Goldbogen⁶

¹Stanford University, Cascadia Research Collective, Pacific Grove, CA, ²Hopkins Marine Station, Stanford University, Pacific Grove, CA, ³Stanford University Hopkins Marine Station, Pebble Beach, CA, ⁴Cascadia Research Collective, Olympia, ⁵Stanford University, Pebble Beach, CA, ⁶Stanford University, Pacific Grove, CA

Individual differences are an important, but often overlooked, factor in organismal biology. Complex ecological contexts present a challenge for controlled comparisons of behavior and physiology in free-ranging individuals. Individuals that exhibit a high degree of synchrony provide a natural experiment for quantifying this variation among conspecifics. In 2019, we tagged a pair of blue whales (Balaenoptera musculus) with high-resolution, medium-duration archival tags near Monterey California, resulting in the longest known continuous observation of a blue whale pair (2.9 days). We examined degree of synchrony in horizontal and vertical movements, and used accelerometers to quantify behavioral (feeding and calling) and physiological (breath-rate and tail-beat frequency) parameters. We observed synchrony in movement and foraging, and asynchrony in social behavior and physiology. The two individuals followed remarkably similar trajectories. Over 2.9 days and a distance of 195 km, they remained within 100 m of each other horizontally (n = 168 GPS location pairs < 1 minute apart) and 8.9 ± 9 m vertically. The individuals also foraged in synchrony, feeding within 2.9 ± 2.8 seconds of each other for a total of 413 and 417 lunge feeding events. Conversely, only one animal engaged in calling (176 calls) and calling bouts were distinct from feeding bouts. The calling animal took 32% (±12%) fewer breaths and beat its tail 7.5% slower. Our results revealed persistent synchrony in a blue whale pair. Despite the similarities in these activity patterns, the individuals varied substantially in social behavior and physiology. This suggests that there may be hydrodynamic benefits for a trailing animal in a pair or potentially morphologically-driven differences in energetic efficiency due to factors such as body size or reproductive status. The high degree of spatio-temporal coupling in this natural experiment demonstrates the value of paired
animals for quantifying intra-specific variation while controlling for environment variability.

NOAA Fisheries’ Update on the Status of the Guadalupe Fur Seal (Arctocephalus philippii townsendi) under the U.S. Endangered Species Act
Christina Fahy1, Laura McCue2, Tenaya Norris3
1National Marine Fisheries Service, Long Beach, California, 2Silver Spring, Maryland, 3Kentfield, California

Guadalupe fur seals (Arctocephalus philippii townsendi) once had a population size of as many as 200,000 animals before they were hunted to near extinction for their fur in the 19th century, although pre-exploitation population estimates vary greatly. This species was thought to be extinct until a Guadalupe fur seal was sighted on San Nicolas Island, California in 1949, and an expedition to Guadalupe Island, Mexico (their primary rookery) in 1954 confirmed the survival of the species. Since the 1950s, the species has recovered from an estimated population of 200-500 animals to a minimum estimate of 31,019 animals in 2013, with an estimated annual population growth rate of 5.9% from 1984-2013. The Guadalupe fur seal was listed as threatened in 1985 under the U.S. Endangered Species Act (ESA). The status of this species was reviewed more than 30 years later, with NOAA Fisheries publishing their report in 2021. After a thorough review of the best available scientific and commercial information and an assessment of threats to the species, NOAA Fisheries determined whether the identified threats were likely to cause Guadalupe fur seals to become or remain in danger of extinction in the foreseeable future throughout all or a significant portion of its range. Guadalupe fur seals have only one main rookery (Guadalupe Island, Mexico), and major threats that impact these seals directly and/or indirectly through their primary prey (squid) include warm water events, storms/hurricanes, sea level rise, ocean acidification, disease, and oil spills. Here, we provide an update on the status of the Guadalupe fur seal under the ESA and NOAA Fisheries’ next steps, including conservation and management recommendations for recovery of this protected species.

Regional variation in humpback whale song within the south Indian Ocean indicates varying movement patterns across years
Adrian FAJEAU1, Violaine Dulau2, Anjara Saloma3, Gill Braulik4, Tahina Rasoloarijao5, Shanan Atkins6, Nakia Cullain7, Michael Mwango'mbe8, John Totterdell9, Kate Sprogis10, Tanguy Guillemain11, Salvatore Cerchio12
1GLOBICE REUNION, LA FONTAINE SAINT LEU, Reunion, 2GLOBICE-REUNION, Saint Pierre, Reunion, 3Cétamada, Sainte Marie, Madagascar, 4University of St. Andrews, Fife, United Kingdom, 5Institut Halieutique et des Sciences Marines, Toliara, Madagascar, 6Animal, Plant and Environmental Sciences, University of the Witwatersrand, mossel bay, South Africa, 7Marine Action Research, Zavora, Mozambique, 8Kenya Marine Mammal Research & Conservation / Watamu Marine Association, Watamu, Coast, Kenya, 9Marine Information and Research Group–Australia (MIRG), Quinns Rocks, Australia, 10Marine Bioacoustics Lab, Aarhus University, Australia, 11Mega-Megafauna, Nosy Be, Madagascar, 12African Aquatic Conservation Fund, East Sandwich, Massachusetts

The movement patterns of humpback whales within the southern Indian Ocean breeding ground are complex and only partially understood. Capture-recapture, genetic and satellite tracking data have revealed varying degrees of population connectivity between sub-regions of the southwestern Indian Ocean (SWIO). This study aimed at analyzing humpback whale songs to provide further insights on temporal distribution, population structure and connectivity at different spatial and
temporal scales. Autonomous recorders were deployed at 9 sites in the SWIO breeding ground, during the austral winters 2016-2020, to assess temporal distribution of song occurrence and compare song structure across sub-regions and years. Recorders were also deployed in Western Australia in winter 2020 for a broader ocean-basin scale comparison. Around 50,000 hours of recording were collected, and presence/absence of humpback whale songs were noted during the first 20 minutes of each hour. The western SWIO showed a consistent high level of occurrence whereas the eastern SWIO had more heterogenous occurrence. High quality recordings of song sequences were used to analyze song structure, based on the description of phrase types. Samples were selected to capture inter-individual, intra-population and inter-population variability within and between years. Twelve phrase-types and 3 main song-types were identified in the SWIO. A single distinct song was recorded each year, except in 2018 when two distinct songs composed of different phrase-types were recorded, suggesting two distinct groups of migrants in the SWIO in 2018. Cultural diffusion of the second 2018 song, with complete replacement of the previous year’s song, was observed by 2019. Preliminary results from 2020 indicated that the same song was shared between SWIO and Western Australia suggesting a possible connection on feeding grounds. This 5-year survey highlights the importance of understanding interactions on feeding grounds and migration routes to better understand SWIO humpback whale population structure and dynamics.

Scratching at the Surfacings: Exploring Extended Surface Intervals in Cuvier’s Beaked Whales
Erin Falcone¹, Gregory Schorr², David Sweeney¹, Brenda Rone¹, Stacy DeRuiter¹, Shannon Coates¹, Russel Andrews⁷, Stephanie Watwood⁸

With respect to the surface, Cuvier’s beaked whales (Ziphius cavirostris, Zc) are mostly known for how remarkably little time they spend there. We deployed five Sound and Motion Recording and Transmitting (SMRT) tags on Zc in Southern California in 2019, which provided high-resolution depth, magnetometer, accelerometer, acoustic, and FastLocGPS data for 0.3-12.4 days (median 5.9). “Surface intervals” (n=669) were defined as periods between dives that exceeded 50 m, following the definition used previously in lower-resolution satellite-linked tags. Parameters including respirations (acoustically detected), depth, heading, and horizontal displacement between GPS fixes were summarized for each surface interval. As expected, the vast majority were very brief (median 1.70 minutes, mean 4.10, SD 10.21) and represented a single respiratory bout averaging 15 breaths (range 1-122), or 7.38 breaths-per-minute (range 0.8-30), between much deeper dives. Whales typically remained above 2 m depth, heading variances were low (mean 1.91 deg, SD 2.43), and whales displaced at an average rate of 2.36 km/hr (SD 1.35) between each surface interval. However, the upper 5% of all surface durations included 34 intervals lasting 18-139 minutes, during which respirations were often clustered in multiple discrete bouts separated by very shallow submergences. During these extended surface intervals, which occurred almost exclusively at night, whales averaged 4.7 m depth, rarely descended below 20 m, and heading variance (mean 3.73 deg, SD 1.99) increased slightly, but generally remained low. Seventeen of these intervals included multiple
GPS positions; during these, whales displaced at 4.54 km/hr on average, with a max rate of 9.98 km/hr between fixes and max net displacement of 15.5 km from first to last fix. These results suggest whales may use these occasional, extended, late-night surface intervals to efficiently relocate without diving.

Identifying and predicting occurrence and abundance of a vocal animal species based on individually specific calls

**Amber Fandel¹, Helen Bailey², Kirsten Silva², Aimee Hoover², Matthew Ogburn², Aaron N. Rice³**

¹University of Maryland, Arlington, VA, ²University of Maryland Center for Environmental Science, ³Cornell University, Ithaca, NY

Passive acoustic monitoring (PAM) offers opportunities to collect data on the occurrence of vocal species for long periods of time, at multiple locations, and under a range of environmental conditions. Some species emit individually distinctive calls, including bottlenose dolphins (*Tursiops truncatus*) that produce signature whistles. Our study used PAM to determine the seasonal occurrence of bottlenose dolphins and utilized individually specific signature whistles to 1) track individuals spatially and temporally, 2) assess site fidelity off Maryland (MD), U.S.A., 3) estimate the minimum density and abundance of dolphins in the study area, and 4) develop a dynamic habitat-based density model as a predictive tool for relative dolphin abundance. Acoustic recorders were deployed at two sites offshore Ocean City, MD and at one site in the upper Chesapeake Bay, MD. Acoustic recordings from 2016 to 2018 were analyzed for signature whistles, and re-occurrences of individual whistles were identified using a combination of machine learning and manual verification. A habitat-based density model was created using the number of signature whistles and environmental conditions. A total of 1,518 unique signature whistles were identified throughout the study area. There were 184 re-occurrences of 142 whistles with a mean of 135 days between re-occurrences (range = 1 – 681 days). These repeated detections of the same individuals occurred most frequently at the site nearest Ocean City, MD, indicating the highest site fidelity. Individual dolphin re-occurrence was recorded between all three sites, indicating movement of dolphins between the Chesapeake Bay and off the Atlantic coast of Maryland. The weekly number of individual dolphins detected off the Atlantic coast was significantly related to sea surface temperature and chlorophyll-a concentration. This habitat model could be used to predict relative dolphin abundance offshore of Maryland and inform management, including in relation to offshore wind energy developers and other stakeholders.

A Comparative Evaluation of Traditional Survey Methods and the Use of a Small Multirotor Drone to Detect the African Manatee (*Trichechus senegalensis*)

**Sarah Farinelli¹, Christogonus Uzoma Ejimadu², David Luther³, Lucy Keith-Diagne³**

¹George Mason University, Springfield, VA, ²Marine Science Department, University of Lagos, Nigeria, ³George Mason University

Drones are increasingly being used to overcome the challenges of detecting elusive, widespread, or inaccessible marine mammals. Recently, drones have been successfully used to detect *Trichechus manatus* spp. in primarily clear, shallow waters. However, the practicality of using drones to detect manatees in turbid, estuarine environments has not yet been assessed. The African manatee (*Trichechus senegalensis*) is the least-studied threatened, large mammal in Africa. Unlike its well-studied counterpart, the Florida manatee (*T. m. latirostris*), there are currently no replicable or reliable methods to detect the species to determine a minimum population count in part
due to the species’ elusive behavior and adaptability. We used a multi-method and repeated sampling approach to compare the detection probabilities of traditional methods (boat-based surveys and indirect detection, including fecal samples and feeding signs) versus automated, aerial parallel line transects conducted using a drone and to compare the effects of environmental covariates (turbidity, depth, water body, sea state, sun glitter, floating vegetation density, and water quality) on detection probability. Surveys were conducted at two lagoons in southwestern Nigeria in both the dry and wet seasons, as seasonality was hypothesized to affect environmental covariates. Boat-based surveys were conducted concurrently with autonomous drone surveys. Preliminary results indicate that even in turbid waters, drones detect manatees as well as boat-based surveys. However, mud plumes created by manatees when their tails hit the muddy, bottom substrate was more commonly detected via the drone than direct physical sightings of the body or snout of the manatee. Overall, indirect detection of manatees resulted in the greatest detection across study sites. We recommend using a combination of methods to improve the detection of the species in complex environments, such as the lagoons surveyed for this study. Results will be updated, with more details provided, at the time of presentation.

Large Whale Transboundary Unusual Mortality Events: Best Practice and Investigation through Coordination and Collaboration

Deborah Fauquier¹, Jorge Urban², Lorena Viloria Gomora³, Sergio Martinez Aguilar⁴, Steven Swartz⁵, Stephen Raverty⁶, Paul Cottrell⁷, Sean MacConnachie⁸, Tonya Wimmer⁹, Laura Bourque¹⁰, Pierre Yves Daoust¹⁰, Megan Jones¹¹, Stéphane Lair¹², Marion Jalengues¹³, Matthew Hardy¹⁴, Hilary Moors-Murphy¹⁵, Angelia Vanderlaan¹⁶, Stephanie Ratelle¹⁷, Brett Gilchrist¹⁸, Elise Lavigne¹⁹, Jessie Huggins²⁰, Jim Rice²¹, Barbie Halaska²², Maureen Flannery²³, Michael Garner²⁴, Padraig Duignan²⁵, Kathleen Burek-Huntington²⁶, Frances Gulland²⁷, Tracey Goldstein²⁸, John Calambokidis²⁹, Sue Moore³⁰, Denise Greig, Michael J Moore³¹, William McLellan³², Alex Costidis³³, Sarah Sharp³⁴, Kim Durham³⁵, Allison DePerte³⁶, Megan Stolen³⁷, David Rotstein³⁸, Craig Harms³⁹, Jason Baker⁴⁰, Kerri Danil⁴¹, Kate Savage⁴², David Weller⁴³, Joshua Stewart⁴⁴, Kristin Wilkinson⁴⁵, Justin Viezbicke⁴⁶, Justin Greenman⁴⁷, Mandy Keogh⁴⁸, Allison Henry⁴⁹, Sean Hayes⁵⁰, Diane Borggaard⁵¹, Barbara Zoodsma⁵², Mendy Garron⁵³, Ainsley Smith⁵⁴, Erin Fougeres⁵⁵, Blair Mase-Guthrie⁵⁶, Eric Patterson⁵⁷, Caroline Good⁵⁸, Shannon Bettridge⁵⁹, Trevor R. Spradlin⁶⁰, Sarah Wilkin⁶¹, Teresa Rowles⁶²

¹NOAA Fisheries, ¿Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico, ³Universidad Autonoma de Baja California Sur, La Paz, Baja California Sur, Mexico, ´Programa de Investigacion de Mamiferos Marinos, Mexico, City, †Laguna San Ignacio Ecosystem Science Program, Darnestown, ‡The Animal Health Center, Abbotsford, British Columbia, §Department of Fisheries and Oceans Canada, Vancouver, British Columbia, ¢Department of Fisheries and Oceans Canada, Nanaimo, British Columbia, £Marine Animal Response Society, NS - Nova Scotia, †Atlantic Veterinary College, Charlottetown, PEI, †Canadian Wildlife Health Cooperative, Charlottetown, Prince Edward Island, ‡Université de Montréal, ST. HYACINTHE, Quebec, ††Canadian Wildlife Health Cooperative, St. Hyacinthe, Québec, ‡‡Department of Fisheries and Oceans Canada, Science Branch, Gulf Region, Moncton, New Brunswick, †††Fisheries and Oceans Canada, Dartmouth, Nova Scotia, †††Fisheries and Oceans Canada, Dartmouth, Nova Scotai, †††Fisheries and Oceans Canada, Moncton, New Brunswick, ††††Fisheries and Oceans Canada, Ottawa, Ontario, ††††Department of Fisheries and Oceans Canada, Ottawa, Ontario, ††††Cascadia Research Collective, Olympia, Washington, †††††Oregon State University, Newport, Oregon, †††††The Marine
Transboundary Unusual Mortality Events (UMEs) have been declared by the United States National Marine Fisheries Service for North Atlantic right whales (Eubalaena glacialis, 2017-present) in the Atlantic Ocean and gray whales (Eschrichtius robustus, 2019-present) in the eastern North Pacific Ocean. To date, mortality and injury events have been documented for 49 right whales across two countries (Canada and U.S.) and 430 gray whales across three countries (Canada, Mexico, and U.S.). The UME for critically endangered North Atlantic right whales has species-level consequences given that population abundance is estimated to be fewer than 400 individuals. Eastern North Pacific gray whales are not endangered, however recent abundance estimates found a ~24% decrease in the population between 2016 and 2020, which is thought to be an outcome of the UME. Causes of the right whale UME have preliminarily been attributed to entanglements and vessel strikes. Causes of the gray whale UME are undetermined, although some mortality has been linked to killer whale predation, entanglements and vessel strikes, and more tentatively to poor body condition related to ecosystem changes occurring in Arctic feeding areas. Transboundary coordination and collaboration has been essential to document the number of animals affected throughout their range, facilitate consistent sample and data collection protocols, and ensure analysis methods can be used in an integrated way. Members of the UME investigation teams include federal, state, and provincial agencies, tribes, academic, and non-governmental partners. These teams meet monthly and communicate in real-time as needed. Additionally, case reviews
have been held annually to discuss findings, refine protocols, and provide information for management. This work would not have been accomplished without the response, collaboration, and dedication of the marine mammal stranding networks in Canada, Mexico, and the U.S.

**Utilization of low oxygen zones by a mesopelagic predator, the northern elephant seal**

*Arina Favilla¹, Rachel Holser¹, Akinori Takahashi², Atsuya Ogata³, Daniel Costa⁴*

¹University of California, Santa Cruz, Santa Cruz, CA, ²National Institute of Polar Research, Tokyo, Japan, ³The Graduate University for Advanced Studies, SOKENDAI, Tachikawa-shi, Japan, ⁴Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA

The deep mesopelagic zone provides critical foraging opportunities for large air-breathing predators. Low dissolved oxygen (DO) waters aggregate prey seeking refuge from water-breathing predators. Northern elephant seals (*Mirounga angustirostris*) are mesopelagic predators that exhibit continuous, diel diving behavior across two annual foraging migrations. Prey capture events documented using animal-borne cameras and jaw accelerometers suggest that seals target sluggish prey in the oxygen minimum zone (OMZ). Previously described regional differences in diet and diving behavior may be influenced by the depth and thickness of low DO zones across the North Pacific. To assess whether seals dive into low DO zones, tracking and diving data (*n*=390) were combined with monthly mean DO data from the Copernicus Marine Service. An index was calculated per dive that compares the maximum dive depth to the OMZ and oxygen-limited zone (OLZ). The index’s density distributions indicate that seals primarily dive into the OLZ during the day rather than the OMZ as previously hypothesized, but regional and seasonal differences were found. The greatest density of daytime dives reaching the OMZ occurred in the California Current, where the OMZ is shallower and OLZ thinner. Outside the California Current, most nighttime dives did not reach the OLZ but remained in high-DO waters during the summer-fall migration. In contrast, during the winter-spring migration, nighttime dives into the OLZ were common, albeit to shallower depths than daytime dives. The greater use of low DO zones during the winter-spring migration may reflect an enhanced foraging effort required to regain mass after fasting and compensate for the shorter trip. Examination of how low DO zones drive their diving behavior and foraging success will be critical for predicting population and ecosystem-level impacts of OMZ shoaling associated with climate change.

**Salinity and Water Temperature as Predictors of Bottlenose Dolphin (Tursiops Truncatus) Encounter Rates in Upper Galveston Bay, Texas**

*Kristi Fazioli¹, Vanessa Mintzer²*

¹Environmental Institute of Houston, University of Houston Clear Lake, Houston, Texas, ²University of Florida, Arden, North Carolina

Bottlenose dolphins (*Tursiops truncatus*) that inhabit urban estuaries like Galveston Bay, Texas, are exposed to cumulative stressors including pollution, fisheries, shipping, freshwater inflows, and construction operations. With continuing development, it is imperative to understand the key environmental variables that make the Galveston Bay estuary suitable habitat for this protected species. The Galveston Bay Dolphin Research Program conducted monthly photo identification surveys of bottlenose dolphins in a previously understudied 186km² area in upper Galveston Bay. To understand occurrence patterns in this region, we calculated monthly encounter rates of dolphins (dolphins/km) for four consecutive years (2016-
Using multiple linear regression models, we investigated the relationship between encounter rates and water temperature and salinity. Monthly encounter rates ranged from 0.00 to 1.23 dolphins/km with an average of 0.34 dolphins/km (SE = 0.05). Over 80% of the variance was explained by the predictor variables water temperature and salinity (R² = 0.820). Water temperature had a positive linear effect on encounter rates at over 23.37°C (SE=1.42). Accordingly, higher encounter rates occurred during months with warm temperatures (May-September) compared to cooler months (November-April), indicating a predictable yearly movement pattern. Moreover, salinity was a highly significant predictor variable, with encounter rates dropping linearly with decreases in salinity. Higher numbers of dolphins are found in upper Galveston Bay during summer, but an exodus of dolphins occurs with low salinity levels, regardless of the time of year and water temperature. These findings should be considered during infrastructure projects (i.e., flood gates) that may alter dolphin habitat and prey availability.

Improving detectability of dolphin signature whistles for capture-recapture analysis: an examination of array configuration using real-world data
Jack Fearey¹, Simon Elwen², Greg Distiller³, Tess Gridley¹
¹University of Cape Town, Cape Town, Western Cape, South Africa, ²Stellenbosch University, Cape Town, South Africa, ³University of Cape Town

Abundance estimates of cetaceans are often acquired through capture-recapture analysis of photographically identified individuals. An alternative method, using capture-recapture of individually distinct signature whistles detected from acoustic underwater recording units, has recently been demonstrated. Here we investigate the effect of array configuration (1 to 3 hydrophones within 0.45 km²) and recording duty cycles (combinations of 33%, 50%, 66%) on the detection rates of dolphin signature whistles. Twenty-one signature whistle types were identified and used to create capture histories for each hydrophone and all potential array configurations. Open population models were used to estimate capture probabilities and precision for all data sets. The effect of different duty cycles on detectability were investigated by artificially applying seven duty cycles to the continuously recorded data. Results demonstrate that location of the hydrophone is more important than number of receivers, even within small-scale arrays, and that duty cycling can increase survey durations without significantly decreasing detectability. To acoustically sample intermittent signals of widely dispersed populations, it is more effective to space hydrophones further apart, in areas that are known to be used. This study provides insight into the application of capture-recapture to signature whistles, improving methods for long-term, noninvasive monitoring of elusive delphinids.

Reducing the Impacts of Anthropogenic Noise on Cetaceans in the Gulf of Mexico
Elizabeth Fetherston-Resch¹, Leila Hatch², Jason Gedamke¹, Laura Engleby⁴, Melissa Soldevilla⁵, Christy Fellas⁶
¹NOAA, SAINT PETERSBURG, FL, ²Stellwagen Bank National Marine Sanctuary, Scituate, Massachusetts, ³NOAA Ocean Acoustics Program, Silver Spring, Maryland, ⁴NOAA/NMFS Southeast Regional Office, ⁵Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL, ⁶NOAA Restoration Center, St Petersburg, FL

Cetaceans in the Gulf of Mexico inhabit a highly industrialized environment with a variety of anthropogenic sources of sound including small and large vessels, oil and gas-related activities, construction, and military operations. Impacts to
marine mammals from noise may include reduced foraging success, reduced reproductive success, masking of communication and environmental cues, and habitat displacement. As part of the BP Deepwater Horizon Natural Resource Damage Assessment settlement, the Open Ocean Trustees funded several projects to restore injury to Gulf of Mexico marine mammals that were injured in the Deepwater Horizon oil spill, including a project to address noise. The Reducing the Impacts of Anthropogenic Noise on Cetaceans in the Gulf of Mexico project will identify high risk areas and source types for restoration, and will work with partners to advance existing noise reduction technologies, implement pilot projects that reduce noise and develop a strategy that will inform future restoration projects to prevent and reduce noise impacts to marine mammals in the Gulf of Mexico. Project managers will oversee implementation activities that include a risk assessment to identify priority areas, identification and development of noise reduction strategies and technologies (with an emphasis on seismic exploration and vessel activity), and working with scientists, managers, industry, and stakeholders to test promising concepts. These pilots will be evaluated for success and inform future restoration strategies aimed at reducing noise in the northern Gulf of Mexico. Monitoring activities will include maintenance of an existing PAM array as well as extending the PAM array to areas with data gaps. Monitoring the noise environment will take place for at least six years and will help to expand baseline data, inform future restoration of the soundscape, and monitor noise reduction outcomes.

According to the International Union for the Conservation of Nature (IUCN) Red List, 29% of marine mammal species are under threat of extinction (listed as critically endangered, endangered, or vulnerable) from multiple anthropogenic factors, and 8.5% of the species are listed as data deficient. In an attempt to counter these numbers, multiple methods of data collection (aerial and ship-based surveys, passive acoustic monitoring, etc.) have been employed to assess species and population stocks of marine mammals to inform on the implementation of conservation and management strategies. However, these traditional methods can be costly, time consuming, invasive, and superficial. Environmental DNA (eDNA) metabarcoding could potentially be used as a tool to compliment these traditional techniques, through the alleviation of the aforementioned disadvantages. The species of marine mammals that inhabit the Gulf of Mexico (in the order Cetacea) are ideal candidates for eDNA metabarcoding due to their wide distribution, similar external morphology, and cryptic and elusive behavior. In this study, eDNA metabarcoding will be used to inventory the species diversity of marine mammals in the Gulf of Mexico. Water samples from the year 2021 were collected at predetermined, randomized sites along the eastern and western Gulf of Mexico. The samples were subjected to DNA extraction and amplification. A set of universal marine mammal primers were used to amplify (through polymerase chain reaction or PCR) a variable region of the 12S mitochondrial rRNA gene. Positive results were sent off for sequencing and species will be identified following bioinformatic analysis.

Utilizing Environmental DNA Metabarcoding to Inventory the Species Diversity of Marine Mammals in the Gulf of Mexico
Amy Fellgren¹, Alexis Janosik¹
¹University of West Florida, Pensacola, FL

Affiliation and Agonism: Observing the Nature of Relationships in Bottlenose Dolphins
Wendi Fellner¹, Barbara Losch², Heidi E. Harley³
¹Disney's The Seas, Epcot, Lake Buena Vista, Florida. ²Disney's The Seas, Epcot, Lake Buena Vista, Florida. ³Disney's The Seas, Epcot, Lake Buena Vista, Florida.
As long-term studies reveal, bottlenose dolphin communities comprise a complex network of individual relationships of variable strengths with both positive and negative valence. Individuals form strong bonds (e.g., mother-calf or male dyads), transient relationships, and also compete against each other for resources. Relationships are built upon individual daily choices, and questions remain about the degree of temporal fluidity of associations between pairs, how the ebb and flow of relationships can be detected, and what factors can be used to indicate the formation of affiliative and competitive relationships among individuals. Synchronous behavior and reciprocity in proximity-seeking are two potential markers of an affiliative relationship where individual choices – to join, to move together, and to leave – are visible to observers. Additionally, the number and degree of rake marks (i.e., socially-applied scratches by a conspecific’s teeth) can be useful as a measure of recent mild or intense social or agonistic interactions. Here we examined social behaviors in a group of male, aquarium-housed dolphins as a means of describing group relationship dynamics. We found that one pair consistently maintained synchrony at a rate higher than all other pairs (mean = 21.5%, p<0.008), and that proximity-seeking was shared between all partners (mean Hinde’s Index = 0.01 on scale of +1 to -1). The number and type of rakes received varied between individuals (range = 0.5 to 6.2/wk for mild rakes and 0.2 to 3.1/wk for deeper rakes) and therefore may be useful as indicators of recent agonistic events. Taken together, these social markers can provide a means of rapidly assessing the relationship status of individuals in both aquarium and ocean settings, particularly when long-term knowledge of individual histories are not available.

Identification of phenotypic characteristics in reproductively successful individuals provides important insights into the evolutionary processes that cause range shifts due to environmental change. Female beluga whales (Delphinapterus leucas) from the Baffin Bay region (BB) of the Canadian Arctic in the core area of the species’ geographic range have larger body size than their conspecifics at the southern range periphery in Hudson Bay (HB). We investigated the mechanism for this north and south divergence as it relates to reproductive activity (RA = total corpora) that combines morphometric data with ovarian corpora counted from female reproductive tracts. Based on the previous finding of reproductive senescence in older HB females, but not for BB whales, we compared RA patterns of the two populations with age and body length. Female beluga whale RA increased more quickly with age (63% partial variation explained) in BB than in HB (41%). In contrast, body length in HB female beluga whale accounted for considerably more of the total variation (12 vs 1%) in RA compared to BB whales. We speculate that female HB beluga whale RA was more strongly linked with body length due to higher population density resulting in food competition that favors the energetic advantages of larger body size during seasonal food limitations. Understanding the evolutionary mechanism of how RA, and potentially fitness, varies across a species’ range will assist conservation efforts in anticipating and mitigating future challenges associated with a warming planet.
Evaluation of the Influence of Marine Mammal Sounds on Acoustic Indices
Liz Ferguson¹, Hannah Clayton²
¹Ocean Science Analytics, San Diego, CA, ²Stanford University

Monitoring species biodiversity is an important element to assessing the impacts of climate change on ocean environments. Soundscape ecology, or the study of acoustic relationships between organisms and their environment, includes an increasing repertoire of novel acoustic indices for evaluating species biodiversity. Although these measurements were developed for studies of terrestrial environments over a decade ago, their application to ocean environments only emerged within the last several years. Our study area is situated in a dynamic region of the California Current Ecosystem where the Ocean Observatories Initiative maintains several broadband hydrophones as part of the Coastal Endurance Array. This site is ideal for the usage of acoustic indices as it meets recommendations put forth by the marine community as recordings and in situ environmental data are continuously collected over extensive time scales. A first step to interpreting acoustic indices and evaluating their utility is to compare measurements to known periods of biologic sounds in the data. In this effort, we calculated the Acoustic Complexity Index, the Bioacoustic Index, the Number of Peak Frequencies Index and the Normalized Difference Soundscape Index. We compared measurements calculated for five-minute audio files to passive acoustic data from spring 2018, which includes detections from fin whales, humpback whales, sperm whales, delphinids and ships. All indices were compared to four aspects of the marine mammal acoustic events: a) the number of species vocalizing, b) the number of calls across all species, 3) the species-specific call rate, and 4) select call characteristics. Although biodiversity measures of terrestrial avian data correlate well to the number of bird species, our findings suggest call rate, bandwidth and amplitude have a greater influence on index measurements. We provide recommendations for the use of combined acoustic indices for monitoring marine mammals within the region.

Baleen hormones reveal the endocrine response of southern right whale, Eubalaena australis, calves to kelp gull wounding at Peninsula Valdés, Argentina
Alejandro Fernandez Ajo¹, Kathleen Hunt², Mariano Sironi³, Marcela Uhart⁴, Vicky Rowntree⁵, A. Carolina Giese⁶, Carina F. Marón⁷, Matías Di Martino⁷, C. Loren Buck⁸
¹Oregon State University, Marine Mammal Institute, GEMM Lab, Instituto de Conservacion de Ballenas de Argentina, Oregon State University, Flagstaff, AZ, ²Smithsonian-Mason School of Conservation, Manassas, Virginia, ³Instituto de Conservación de Ballenas, Buenos Aires, Argentina, Buenos Aires, Argentina, ⁴University of California, Davis and Universidad del Centro de la Provincia de Buenos Aires, Argentina, Puerto Madryn, Chubut, Argentina, ⁵Department of Biology, University of Utah, Salt Lake City, Utah, ⁶Universidad Nacional de Cordoba and Instituto de Conservacion de Ballenas, Argentina, ⁷Programa de Monitoreo Sanitario Ballena Franca Austral, Buenos Aires, Argentina, ⁸Northern Arizona University, Flagstaff, Arizona

Physiological measurements provide evidence of stressors that impact the health of wildlife. Baleen accumulates hormones as it grows, allowing the use of these samples for retrospective assessment of long-term trends in a whale's physiology. Methodological experiments were conducted to optimize sample use of baleen. Our results indicated that baleen sample masses as low as 20 mg produce reliable and repeatable hormone data. We utilized these methods to assess the endocrine response of southern right whale (SRW, Eubalaena australis)
calves to kelp gull (KG, *Larus dominicanus*) wounding. In Península Valdés (PV), Argentina, KG are considered micro-predators of living SRW, which results in intense harassment and sizable wounds on the whales’ backs. KG harassment has been proposed to contribute to high calf mortality experienced by the SRW population off PV in 2007-2013. We quantified lifetime patterns of glucocorticoids (GCs, an index of general physiological stress) and thyroid hormone (T3, an index of metabolic stress) in baleen recovered at necropsy from 36 SRW calves (~ 1 and 4 months old) with varying severity of KG lesions. GC levels correlated positively with the degree of wounding, while T3 remained stable irrespective of the severity of KG lesions. Our results indicate that heavily wounded calves suffered high levels of physiological stress (increased GCs levels) throughout their short lifespans. However, we found no evidence of malnutrition in mildly vs. severely wounded calves. Thus, considering the negative effect that chronic elevations in GCs levels might pose to SRW calves’ growth and immune system, KG wounding and harassment may have contributed to the high calf mortality observed at the PV calving ground.

**Change in expression of cytokine mRNA observed in cold stressed Florida manatees (Trichechus manatus latirostris)**

**Jason Ferrante**, Maggie Hunter


Cold stress syndrome (CSS) in Florida manatees is attributed to an average 10% of total mortality annually. That number can vary depending on the severity of the winter, e.g., 37% in a colder year (2010) vs 5% when milder (2013). Upon necropsy, manatees with CSS show physical symptoms associated with suppressed immunity, suggesting susceptibility to secondary infections. Cytokines are innate and adaptive immune proteins with important roles in the mammalian response to viral and bacterial infections, trauma, and wound healing. Xenograft models show that differentially expressed mRNA levels correlate more closely with protein levels than genes that don’t change their expression in response to a stimulus. By looking for differentially expressed cytokine mRNA in cold stressed manatees, we aim to identify specific immune pathways being affected. We used species-specific quantitative PCR assays to measure mRNA expression of genes associated with immune function in Florida manatees. Blood samples were obtained from adult to subadult manatees during health assessments in Brevard County, FL during December of 2010 (N=10; confirmed for CSS), and 2013 (N=10; no signs of CSS). Our study site is currently undergoing an unusual mortality event for which the synergistic effects of CSS are of concern. Manatees from the CSS group displayed significant reductions in IL-2, IL-10, and TNF-α, while IL-6 and the internal control gene β-actin remained unchanged. Reduced cytokine expression was hypothesized based on previous studies showing CSS suppresses manatee lymphocyte proliferation and would likely inhibit a manatee’s response to infection. Specifically, CSS may hinder the acute phase reaction, an important part of the early innate immune response. This study begins to fill in a gap in our understanding of the immunosuppressive effect of CSS in the Florida manatee. Further characterizing the nature of cold stress on immune function may inform treatment following future live strandings.

**Whale Tails: site fidelity and residency times of sperm whales Physeter macrocephalus in an oceanic archipelago (NE Atlantic)**

**Rita Ferreira**, Ana Dinis, Anja Badenas, Annalisa Sambolino, Manfred Kaufmann, Filipe Alves

1*MARE-Madeira, Portugal, 2MARE/ARDITI/OOM, Funchal, Portugal, 3MARE- Marine and Environmental Sciences*
The sperm whale *Physeter macrocephalus* is one of the most iconic large whales worldwide, presently classified as "Vulnerable" by the IUCN. With a circumglobal distribution, their home ranges may span thousands of kilometers, with marked differences in distribution according to sexes. This species is among the most frequently sighted cetaceans in Madeira Archipelago, located in the Macaronesia biogeographic region. Although the species is known to use the Madeiran waters for birthing, feeding, resting, and socializing, there is still no information on site fidelity patterns or residency time estimates. A capture-history dataset based on photographic data of sperm whales collected year-round between 2008-2019 was used to determine short- (intra-seasonal) and long-term (inter-annual) site fidelity and to estimate individual residency times through Lagged Identification Rates (LIRs). A total of 281 highly distinctive individuals were catalogued, of which 80.4% were captured only once, and 19.6% were captured on multiple occasions. From the recaptured individuals, six whales (10.9%) showed short-term site fidelity and 49 (89.1%) long-term site fidelity, with a maximum recapture interval of 8 years. LIRs showed that 95 individuals (SE=32) remained in the area for 598 days (SE=309) and emigrated for 1126 days (very large SE). Although the percentage of recaptured individuals is small, the high long-term site fidelity is indicative of the importance of the area for at least some sperm whales. This is supported by the LIR results, where the occasional visits from males are a possible explanation for the long emigration period. These preliminary results reflect the need for more data to establish precise site fidelity and residency patterns since the population is still far from being fully captured. Such basic but essential information provides the baseline for future management measures towards the conservation of this species in this area of the Atlantic.

The South American sea lion (*Otaria byronia*) has a wide distribution in South America. Occurring from northern Peru south to Cape Horn, and north up the east coast of the continent to southern Brazil. The breeding location on the Atlantic side ranges from Tierra del Fuego to the coastal island Ilha dos Lobos in Torres in southern Brazil; but individuals have been seen as far north as Río de Janeiro. In July 2019, 18 sea lions were seen resting on the rocky shore of Matadeiro beach in Santa Catarina Island/City of Florianópolis/SC (27°45'S), since then the site has been monitored at least once a month. The aim of this study is to evaluate the occurrence of sea lion in the South of Santa Catarina Island. In the place there is always the presence of sea lions throughout the year, the numbers vary from 2 to 10 animals. Although there are no breeding colonies in Brazil, many sea lions are found there throughout the year, grouped in specific places to rest (Ilha dos Lobos, Torres – 29°20’S and Molhe Leste, São José do Norte – 32°11’S), or swimming in coastal waters in winter and spring months. Since many sea lions make seasonal movements away from their reproductive colonies in search of feeding grounds. There are no breeding colonies in Brazil, so it has been suggested that individuals in Brazil come from the breeding colonies off Uruguay after their...
breeding period. Santa Catarina Island is possibly a new feeding ground throughout the year. Monitoring the presence of the species throughout the year is an important measure to assess interactions of the species in the region, to describe occurrence and habitat use in the region, and represents an important tool to propose management and conservation measures for the species.

Analysis of hematological and serum biochemistry profiles of marine manatees (Trichechus manatus) in acclimatization in Ceará, Brazil.
Gabriela Ferreira¹, Diego Pinheiro², Vitor Luz Carvalho³
⁠¹School of Veterinary Medicine and Animal Science (FMVZ) of University of São Paulo (USP), Araraquara, São Paulo, Brazil, ²Aquasis, ³Associação de Pesquisa e Preservação de Ecossistemas Aquáticos, Fortaleza, Ceará, Brazil

Releasing rehabilitated animals is the main conservation strategy for small populations of marine manatees in the northeast of Brazil. After years of rehabilitation, they face changes in habitat, diet, and water quality in the acclimatization stage, which can lead to variations in their hematological and biochemical parameters. This study evaluated the hematology and serum biochemistry of marine manatees held in captivity for acclimatization installed at sea. The complete blood count and eight biochemical parameters of five clinically healthy adult animals, maintained for 35 to 192 days in acclimatization, were analyzed. Regarding the ranges and mean values of the hematological parameters found, only the values of heterophils (mean: 4,590/mm³; range: 3,384/mm³ - 6,396/mm³) was higher than previously described for the species in another captivity of acclimatization in Brazil. In the serum biochemistry parameters, the mean values and ranges found for aspartate aminotransferase (mean: 39 U/L; range: 13 – 52 U/L), alanine aminotransferase (mean: 20 U/L; range: 10 – 34 U/L) and creatine kinase (mean: 379 U/L; range: 105.2 – 1,376 U/L) were higher than those reported in previous studies, a fact that may be associated with higher muscle activity in this period. In the results obtained from an individual immediately after being transported to the acclimatization captivity, the values of aspartate aminotransferase (51 U/L), urea (46 mg/dL), and creatine kinase (982 U/L) were considerably higher, which may be related to muscle stress due to the duration of transport (ten hours) and immobilization. These results are important to establish parameters for the clinical and hematological findings of animals in acclimatization and to help improve the monitoring and management of individuals and the team’s response to abnormalities.

Blue Whale (Balaenoptera musculus) Mother/Calf Pair Behavioral Responses to Vessels in the Southern California Bight
Dagmar Fertl¹, Mari A. Smultea², Frances C. Robertson³
¹Ziphius Ecoservices, Magnolia, Texas, ²SES-Smultea Environmental Sciences LLC, Preston, Washington, ³San Juan County, Washington State, USA

Systematic focal observations of endangered blue whale (Balaenoptera musculus) mother-calf behavior are rare, with little known about potential disturbance reactions to vessels. As part of a larger study, blue whale mother-calf (MC) behavior was opportunistically documented for 54 min using video from a small fixed-wing observation aircraft before, during and after a close approach by two different 5-6-m recreational vessels off Southern California on 24 May 2013. Using scan and focal individual sampling protocol we quantified four behavior metrics: percentage of time in view, inter-individual distance between MC in mother body lengths (BL), position of calf relative to four
quadrants around the mother, and mean blow interval. Behavior metrics were compared before, during and after vessel presence. In vessel presence, maximum spacing between MC increased from 1 to 2 BL, as did mean MC separation distance (n=81 30-sec scan samples). Vessel presence had no detectable effect on the mother’s blow interval but led to a nominally significant increase in calf blow interval (p=0.002). Vessel presence did not affect calf position relative to the mother; overall, the calf was positioned in the mother’s rear left quadrant in 31% of scans. During vessel absence, the calf appeared to nurse three times. The most notable apparent reaction occurred when a vessel approached the MC, the calf then approached the vessel but sprinted away creating white water when the vessel suddenly increased speed and departed. This resulted in the largest observed inter-animal separation distance of approximately 2 BL between the MC (prior and after this encounter this distance was 0.1-1 BL). Results indicated short-term initial curiosity (approach) by the calf to vessel presence followed by behavioral disturbance in response to the vessel’s sudden change in speed manifested by the calf suddenly moving away then returning to previous close proximity to the mother.

Does Geographic Variation in Fin Whale (Balaenoptera physalus) Calls Reveal Population Identities in the Weddell Sea?
Victoria Field¹, Elke Burkhardt², Ilse Catharina Van Opzeeland³

¹Alfred Wegener Institute, BREMEN, Bremen, Germany, ²Alfred-Wegener-Institut Helmholtz-Zentrum für Polar und Meeresforschung, Bremerhaven, Germany, ³Afred Wegener Institute for Polar and Marine Research, Bremerhaven

This study examined the geographical variation of fin whale (Balaenoptera physalus) calls across the Weddell Sea. Currently, little is known about the population identity of fin whales in Antarctic waters but initial analyses of acoustic recordings

Rachel Finn¹, Edward Lyman², Lars Bejder³, Jens Currie⁴, Martin van Aswegen⁵, Jason Moore⁶, Stephanie Stack⁷, Ted Cheeseman⁸, Marc Lammers⁹, Sarah Wilkin⁹, Trevor R. Spradlin¹⁰

Entanglements are a significant anthropogenic source of injury and mortality for large whales worldwide. However, quantifying their incidence and impact through reporting alone underestimates the threats. Scar analysis, the systematic evaluation of scarring consistent with prior non-lethal entanglements, provides additional information towards assessing the impacts of entanglements. Many efforts evaluate surface-obtained imagery of the caudal peduncle region. Recently, scar analysis has expanded to include aerial images obtained from unoccupied aircraft systems (UASs; drones), and underwater images obtained from handheld and pole-mounted cameras. Theoretically, and if conditions allow, both provide a more comprehensive analysis of body regions not readily observable otherwise. Here we compare scar analysis results for North Pacific humpback whales (*Megaptera novaeangliae*) on their principal wintering grounds of Hawaiʻi using surface, aerial, and underwater imagery of uniquely identified animals. Conditional scar rates (unambiguous scars only) on randomly-selected individuals similarly evaluated and compared, were 20.2% (n = 525, CI = 3.4, 2013-2020) for surface, 11.1% (n = 80, CI = 7.8, 2015-2021) for underwater, and 10.4% (n = 60, CI = 8.2, 2021) for aerial. Preliminary results indicate scar rates for underwater and aerial-based imagery were lower than surface-based imagery. While potentially more comprehensive, underwater and aerial-based analyses pose additional challenges depending on conditions, optics, logistics and platform limitations (e.g., exclusion of mouth entanglements from aerial).

As scar rates may change over time, and the analysis is subjective, future analysis will focus on smaller and temporally confined datasets, representing the same animals using differentially-obtained imagery, along with those known to have been entangled. The results presented here illustrate the differences, benefits and challenges towards determining scar rates based on image source, with trade-offs between safety, invasiveness, efficiency, and comprehensiveness. Single-platform studies may be able to extrapolate from this comparison to obtain a more comprehensive understanding of entanglement threats.

### Rate of chuffing (explosive exhalations) by bottlenose dolphins increases during red tide exposure

**Spencer Fire**, Florida Institute of Technology, Melbourne, Florida

Harmful algal blooms (HABs) such as those produced by *Karenia brevis* have acute negative impacts on common bottlenose dolphins (*Tursiops truncatus*) in Florida coastal waters, frequently causing illness and death. However, much less is known about chronic, sub-acute effects on these important sentinel species. This study investigates whether bottlenose dolphin behavior in Sarasota Bay, Florida is influenced by the presence of severe red tide events, focusing on respiratory and other behaviors likely affected by abundant toxin aerosols produced during these blooms. Through focal animal behavioral follows, we observed free-ranging dolphin respiratory behavior, activity budgets, and movement patterns relative to *K. brevis* abundance in the study area. We compared behavior from dolphins observed during a 2005 *K. brevis* bloom to those observed during inter-bloom conditions where *K. brevis* was present at background concentrations. We found that the rate of “chuffing”, an explosive type of exhalation, was significantly greater in dolphins observed during the bloom. No apparent effect on respiratory
rate, heading change rate or activity budgets was observed. We propose that this chuffing behavior is analogous to symptoms of respiratory irritation observed in humans exposed to such red tide events, and suggest that this may be a type of disturbance response. With an observed increase in both the frequency and severity of HABs, such disturbance responses may have large-scale chronic impacts to the health and fitness of bottlenose dolphins in regions where such HABs are common.

Spin-leap performance by cetaceans is influenced by moment of inertia

Frank Fish¹, Anthony Nicastro², Kaitlyn Cardenas², Paolo Segre³, William Gough¹, Shirel Kahane-Rapport¹, Judith St. Leger⁴, Jeremy Goldbogen⁵

¹West Chester University, West Chester, PA, ²West Chester University, ³Stanford University, Chico, California, ⁴Stanford University, Pebble Beach, CA, ⁵Hopkins Marine Station, Stanford University, Pacific Grove, CA, ⁶Sea World San Diego, San Diego, CA, ⁷Stanford University, Pacific Grove, CA

Cetaceans are capable of extraordinary locomotor behaviors both in water and air. Whales and dolphins can execute aerial leaps by swimming rapidly enough to the surface of the water to achieve an escape velocity. Previous research on spinner dolphins demonstrated the capability of leaping and completing multiple spins around their longitudinal axis with high angular velocities. This prior research suggested that the slender body morphology of spinner dolphins, together with the shapes and positions of their appendages, allowed for rapid spins in the air. To test if greater moments of inertia reduced spinning performance, videos of cetaceans above and below the water surface were obtained. It was determined that the principal factors affecting the number of aerial spins a cetacean can execute were the moment of inertia of an individual and the use of control surfaces for subsurface corkscrewing, which are both morphology-dependent. For a typical individual spinner dolphin, Pacific striped dolphin, bottlenose dolphin, minke whale, and humpback whale, each with swim speeds of 6-7 m/s, a speed close to their maximum, our model predicted that the number of aerial spins executable were 7, 2, 2, 0.76, and 1, respectively, which was consistent with observations. These data implied that the rate of subsurface corkscrewing was limited to 14.0, 6.8, 6.2, 2.2, and 0.75 rad s⁻¹ for spinner dolphins, striped dolphins, bottlenose dolphins, minke whales, and humpback whales, respectively. In our study, the moment of inertia of the cetaceans spanned a 21,000-fold range. The greater moments of inertia for the latter four species produced large torques on control surfaces that limited subsurface corkscrewing motion and aerial maneuvers compared to spinner dolphins.

Development of apneustic breathing in Weddell seal (Leptonychotes weddellii) pups

Elise Fiskum¹, Linnea Pearson², Emma Weitzner³, Shane Petch⁴, Jay Rotella⁵, Madeline Schroth-Glanz⁶, Hunter Glanz⁶, Heather Liwanag⁶

¹California Polytechnic University, Spring Grove, IL, ²California Polytechnic State University, ³Montana State University, Bozeman, MT, ⁴Montana State University, ⁵California Polytechnic University, San Luis Obispo, CA, ⁶California Polytechnic State University, San Luis Obispo, California

The ability to perform prolonged apnea (breath hold) is a key adaptation in diving mammals. This apneustic ability is seen during the mammalian dive response, in which apnea, bradycardia, and peripheral vasoconstriction contribute to oxygen conservation during a dive. Pinnipeds (seals, sea lions, walruses) are known to practice apnea on land as well as
during the dive response, and the ability to extend breath hold duration tends to increase with ontogeny. The practice of apnea on land and in the water helps to increase a pup’s control over its cardiorespiratory system. In this study, we examined the development of apneustic breathing in the Weddell seal (Leptonychotes weddellii), a deep-diving species, throughout the dependence period. We hypothesized that both age and early experience in the water would influence the development of apneustic breathing. To test this, we characterized the respiratory patterns of known-age Weddell seal pups (n=19) using video footage of pups resting on ice, every 1-2 weeks from 1 week through 7 weeks of age. We quantified eupneic (i.e., normal) respiration rate (breaths/min), presence/absence of apneustic breathing, and apneustic interval (length of breath hold) for each recording. We found that most animals did not perform apnea until after their first entry into the water, and apneustic interval was significantly positively correlated with age ($r^2=0.429$, $P<0.0001$). However, we did not find any correlation between apneustic interval and dive depth or duration, suggesting development of apnea was associated with time in the water rather than diving experience. These results are consistent with early developmental patterns in other pinnipeds, but this is the first study to correlate the development of apnea with early behavioral experience in the water. Time spent in water facilitates the capacity to practice apnea, which in turn develops the cardiorespiratory capacity for successful dives during the transition to independence.

New Holocene gray whale (Eschrichtius robustus) skeleton from North Carolina: the most complete North Atlantic gray whale occurrence

Alyson Fleming¹, Nicholas Pyenson², Briana Probiner²
¹University of North Carolina Wilmington, ²Smithsonian Institution, National Museum of Natural History, Washington, DC

Skeletal remains and historical evidence indicate that gray whales (Eschrichtius robustus) existed in the North Atlantic Ocean from the Pleistocene into the 17th century. Both fossil and sub-fossil occurrences are rare, with approximately 50 vouchers currently identified from the eastern coast of the United States to Europe. Thus, each new finding provides significant insights in the ecology, life history, range and extirpation of this lineage in the North Atlantic. Here, we report on a new Holocene record of gray whale skeletal remains from Pender County, North Carolina. The specimen is housed at the University of North Carolina Wilmington mammal collection and was accessioned in 1987 but was initially recorded as humpback whale (Megaptera novaeangliae). This specimen includes 42 cranial and postcranial elements and is the most complete North Atlantic gray whale specimen reported to-date, including the cranium, parts of the rostrum, mandibles, radii and ulnae, vertebrae and ribs. Skull measurements and morphology suggest it is a yearling. Its provenance near the inlet of a large estuary is consistent with previous findings from the southeastern US and parallels the species habitat use patterns in the North Pacific in the Baja Peninsula breeding and calving grounds. Radiocarbon dating indicates the specimen is from 1360 +/- 15 BP. Cut-marks on multiple elements of the skeleton, including some with bilateral symmetry, suggest that the animal was butchered. Given the age, butchery marks were likely implemented with stone tools and thus suggest some level of human exploitation of the species in the 7th century, approximately a millennium prior to its extirpation in this basin.

Ship strikes on large whales in the Salish Sea, Washington State: Insights from recent strandings and two well-documented fatal strikes by Washington ferries
Ship strikes on large whales are of growing concern around the world as shipping traffic and speeds have increased and whale populations have recovered. In most cases ship strikes go undocumented, neither observed by crew or a stranded carcass. We report the details on recent observations of ship strikes and strandings of humpback whales in the Salish Sea that provide insight into this issue. Humpback whale populations have increased on the US West Coast and in the late-2000s returned in numbers to the Salish Sea, where they were common prior to whaling in the early 1900s. On two separate occasions (28 May 2019 and 6 July 2020), humpback whales were hit and killed in Puget Sound by Washington State ferries and were observed by a combination of passengers, people on shore, and a whale-watch vessel. Unlike most ship strikes, there was good documentation of the location, speed, and identity of the whale involved. From dorsal fin and fluke images we tracked sightings of these whales prior to the strike and with follow-up, confirmed they were not seen again after. Both cases occurred inside protected waters where stranding would have the highest chance of being detected yet no carcass was ever found. For the last 40 years, all seven known strandings of humpback whales in Washington inside waters occurred starting in 2015, with at least 3 of them the result of ship strike (not including the two observed). The recent return/expansion of humpback whales into the Salish Sea puts them at added risk as these two ferry-strikes did not even occur at locations of greatest overlap of whale distribution and shipping traffic. The complete documentation of these two strikes and the absence of a carcass recovery illustrates why ship strikes are severely underreported and highlights the threats to recovering whale populations.

Prevalence and severity of skin lesions in the Burrunan dolphin (Tursiops australis) during an outbreak of suspected freshwater skin disease

Chantel Foord¹, Dayanthi Nugegoda², Kate Robb³
¹Marine Mammal Foundation & RMIT, Australia, ²RMIT, Bundoora, Victoria, Australia, ³Marine Mammal Foundation, Mentone, Victoria, Australia

Epidermal lesions have been documented in a number of cetacean species, and have been linked to compromised immune systems due to high contaminant concentrations and exposure, and/or environmental factors such as temperature and salinity. Lesions may come from viral, bacterial, fungal or ciliate sources with pathology studies identifying infectious diseases and pathogens such as poxvirus, herpesvirus, and lacaziosis as some direct causes. More recently freshwater skin disease (FWSD) has been described linked to a dramatic decline in salinity and prolonged exposure to freshwater. Using photographic data is a non-invasive approach to monitoring a population, with lesion classifications made based on visual assessments linked to disease via histopathology and genetic analysis (via PCR) in stranded individuals. The Burrunan dolphin is an endangered species, with a small, resident and maternal-based population of ~65 dolphins within the Gippsland Lakes, Victoria, Australia. Throughout 2020/2021 period, we observed an increased prevalence of skin lesions, associated with a mortality event of >15% of the population. Here we present the lesion prevalence and severity within the Gippsland Lakes Burrunan dolphin population during an outbreak of suspected freshwater skin disease.
disease. Throughout 2019-2021, 11 seasonal boat-based surveys were undertaken collecting 130,000+ photographic images. This photographic data was used to assess lesion type, prevalence, severity, and persistence in the population. Observed, was an increased prevalence of dark amorphous, white amorphous and ulcerated lesions. Throughout the study period we observed secondary fungal or algal growth, in particular on the highly compromised or deceased dolphins, in-line with FSWD classification. Overall, assigned severity codes were higher (more severe) throughout 2020 compared to the same seasons in 2019. This multi-year data provides valuable information on the prevalence of disease, as well as the progression and potential recovery on an individual and population basis.

### Changing rates of tool use in bottlenose dolphins over the course of a long-term study

**Vivienne Foroughirad¹, Eric Patterson², Anna Kopps¹, Céline Frère³, Ewa Krzyszczyk⁴, Janet Mann⁵**

¹Georgetown University, MOREHEAD CITY, North Carolina, ²Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, SILVER SPRING, Maryland, ³Sydney, Australia, ⁴University of the Sunshine Coast, Sippy Downs, Queensland, Australia, ⁵Georgetown university, WASHINGTON, DISTRICT OF COLUMBIA, ⁶Georgetown University, Washington, DC

Indo-Pacific bottlenose dolphins in Shark Bay, Western Australia are well-known for their use of marine sponges as tools for extractive foraging. Tool use within the study site is largely restricted to specialized subsets of the population inhabiting deeper rocky channels where marine sponges grow and benthic prey are abundant. Decades of research have shown that tool use is vertically socially transmitted from mother to offspring, and that tool use promotes social homophily, making it an important cultural component of the Shark Bay behavioral repertoire. Previous models of sponge foraging transmission have used genetic relatedness among tool users to date the tradition’s emergence in the eastern gulf to circa 160 years, under the conditions of stable learning fidelity rates and fitness benefits. However, recently observed rates of tool use have declined from a high of 51% of encounters within channel habitat in 2008, to a low of 17% of encounters in 2019. Several concurrent phenomena may explain this decrease in prevalence, including depletion of tool availability. We evaluate three non-mutually exclusive hypotheses to explain the reduction in tool use, 1) unusual sponge mortality following an extreme climate event in 2011; 2) top-down sponge depletion by tool-using dolphins; and, 3) re-emergence of alternative prey sources. We examine the roles individual plasticity, fitness, and learning fidelity play in the observed decrease, and extrapolate the consequences for the future of sponging in Shark Bay.

### Determining Call Function in Humpback Whales using Conspecific Playbacks

**Michelle E.H. Fournet¹, Leanna Matthews², Anne Bartlett³, Natalie Mastick⁴, Fred Sharpe⁵, David Mellinger⁶, James Crutchfield⁷, Brenda McCowan⁸, Laurance Doyle⁹, Aaron N. Rice⁹**

¹Sound Science Research Collective, ²Sound Science Research Collective, Juneau, AK, ³Cornell University, Bellingham, Washington, ⁴University of Washington, ⁵Alaska Whale Foundation, Seattle, WA, ⁶Cooperative Institute for Marine Resources Studies, NOAA Pacific Marine Environmental Laboratory and Oregon State University, Hatfield Marine Science Center, Newport, OR, ⁷University of California, Davis, Davis, CA, ⁸SETI Institute, ⁹Cornell University, Ithaca, NY

Understanding the behavioral function of cetacean sounds offers the opportunity to provide
more mechanistic knowledge or inference on whale behavioral states from passive acoustic data, an area with ongoing data gaps in mysticetes. In addition to their song, humpback whales (*Megaptera novaeangliae*) produce calls or ‘non-song vocalizations’ — vocalizations produced outside of song context. Despite growing interest in calling behavior, the function of most call types is unknown. Among identified call types, the ‘whup’ call is ubiquitous, innate and may serve as a contact call. We conducted an acoustic playback experiment combined with acoustic localization and visual observations to test the function of the whup on a Southeast Alaskan foraging ground. Using a before-during-after design, we broadcasted either the sound of running water or a one of ten unique whup call sequences. We investigated the change in humpback whale whup rates (whups/whale/minute) in response to treatment (conspecific or control) and period (before, during, or after). Using general linear mixed models, we determined that the relationship between whup rates and period was significantly different between treatments. In 100% of the surveys where conspecific treatments were broadcast (n=8), whup rates increased during broadcasts of whup playbacks, and were significantly higher than in before or after periods (mean during= 1.2 ± 0.18, mean before=0.3± 0.18, mean after=0.4 ± .0.18). There was no significant difference in whup rates between before and after periods during conspecific trials. In control trials (n=7), there were no significant differences in whup rates between before, during or after periods. Whups did not appear to elicit an approach response; the average distance between whales and the playback speaker did not vary with either treatment or period. Humpback whale responses to whup playbacks suggests that whups function as a contact call, but not exclusively as an aggregation signal.

**Historical foraging ecology of beluga whales** (*Delphinapterus leucas*) **in the Pacific Arctic**

**Devin Fraleigh¹**, Alyson Fleming²

¹University of North Carolina Wilmington, Wilmington, NC, ²University of North Carolina Wilmington

The Pacific Arctic has been changing rapidly over the last several decades, with warming temperatures having a myriad of effects on the ecosystem including dramatic reductions in sea ice extent, shifts in biological communities, and changes in patterns of primary production. Yet little ecological data exists from the period of time before major climate changes began, limiting understanding of past ecosystem conditions and establishment of ecological baselines. Using historical museum collections of teeth from belugas, a sentinel species for tracking change across the Pacific Arctic, this project aims to create a new archive of historical conditions in the Pacific Arctic from approximately 1850 to 1980. Carbon and nitrogen stable isotope analysis performed on samples drilled from individual tooth growth layer groups (GLGs) will provide valuable information on beluga foraging ecology, including habitat and trophic level for each year of an individual’s life. With the inclusion of compound specific isotope analysis, a more recent methodology, underlying shifts at the base of the food web will also be examined. Data from 9 Smithsonian specimens of beluga teeth from 1847-1898 from the Bering, Chukchi, and Beaufort Seas have already been collected and analyzed. We will analyze additional specimens identified in other biological collections from the same region dating from the 1900s. The resulting historical baseline will provide a unique opportunity to directly compare changes both in the foraging behavior of beluga as well as the marine food web before the most significant anthropogenic impacts began and will help inform management of Pacific Arctic marine resources.
Using sonobuoys and visual surveys to characterize North Atlantic right whale (Eubalaena glacialis) acoustic ecology in the Gulf of St. Lawrence

Kimberly Franklin1, Christopher Taggart2, Tim Cole1, Danielle Cholewiak2, Peter Duley2, Leah Crowe3, Philip Hamilton1, Amy Knowlton4, Hansen Johnson1
1Dalhousie University, 2Department of Oceanography, Dalhousie University, Halifax, Nova Scotia, 3Northeast Fisheries Science Center National Oceanic Atmospheric Administration, Woods Hole, MA, 4Northeast Fisheries Science Center / NOAA Fisheries, Woods Hole, Massachusetts, 5Northeast Fisheries Science Center National Oceanic Atmospheric Administration, 6Integrated Statistics / Northeast Fisheries Science Center, 7Anderson Cabot Center for Ocean Life, Boston, Massachusetts, 8Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, MA

The appropriate use and interpretation of passive acoustic data for monitoring the critically endangered North Atlantic right whale (Eubalaena glacialis: hereafter NARW) relies on knowledge of the NARW sound repertoire and how it varies with respect to time, space, demography and behavior. To assess such relations in a habitat of increased management importance, the Gulf of St. Lawrence, Canada, sonobuoys (disposable, drifting hydrophones) were deployed to record sounds produced from aggregations of NARWs during visual aerial surveys in the summers (June through August) of 2017 ($n= 8$), 2018 ($n= 13$) and 2019 ($n= 16$). Acoustic data from each sonobuoy deployment were manually reviewed for NARW upcalls, gunshots, and various mid-frequency (250-800 Hz) tonal calls. The calls were quantitatively compared to concurrently collected NARW demographic and observed behavioral variables using correlation matrices, linear regressions and generalized linear models. Our results provide evidence that 1) call rates increased from June to August for all call types, 2) calling rates were too variable to provide reliable density estimates of observed NARWs, 3) calling rates were associated negatively with observed foraging behavior and positively with observed socializing behavior, 4) upcalls, which are commonly considered contact calls, were occasionally produced in great numbers (> 20 calls h$^{-1}$) and in association with gunshot and tonal calls. Though acoustic density estimation does not appear practical, the observed associations between whale calling and behavioral state provide evidence that we may be able to reliably infer whale behavior from acoustics alone, and thus advance passive acoustic monitoring for NARW beyond a presence-only tool.

Fecal DNA metabarcoding identifies recent prey consumed by polar bears from East Greenland and the Southern Beaufort Sea and explains variation in their gut microbiome

Megan Franz1, Lyle Whyte1, Todd Atwood1, Damian Menning2, Sarah Sonsthagen2, Kristin Laidre3, Emmanuel Gonzalez3, Sandra Talbot4, Melissa McKinney5
1McGill University, Sainte Anne de Bellevue, Quebec, 2McGill University, Ste. Anne de Bellevue, Quebec, 3Alaska Science Center, Anchorage, Alaska, 4USGS Alaska Science Center, Anchorage, Alaska, 5USGS Cooperative Fish and Wildlife Research Units Program: University of Nebraska-Lincoln, Lincoln, Nebraska, 6University of Washington, Seattle, WA, 7McGill University, Genome Quebec Innovation Centre, department of Human Genetics, Montreal, Quebec, 8Retired, 9McGill University, Ste-Anne-de-Bellevue, QC

Polar bears (Ursus maritimus) occupy variable sea ice habitats across the circumpolar Arctic, which results in variation in use of onshore habitats, food resources, and possibly in their gut microbiome. We used a metagenomic approach targeting pinniped and cetacean prey DNA to identify prey presence, and estimate prey relative
abundance, in fecal samples of East Greenland (EG) and Southern Beaufort Sea (SB) polar bears in the spring between 2015 to 2019. Ringed seal (*Pusa hispida*) was the predominant prey species present, identified in 100% of EG polar bears and 81% of SB polar bears. Bearded seal (*Erignathus barbatus*) DNA was found in 19% of SB polar bears. We compared prey presence and relative abundance to that estimated from quantitative fatty acid signature analysis (QFASA) for a subset of SB polar bears. Prey relative abundances from the DNA-based approach were consistent with the rank order found using QFASA. Prey DNA relative abundance was not correlated with the QFASA diet estimates (ringed seal: rho <0.15, p > 0.54). DNA-based prey detection ($R^2 = 0.03$), sex/age class ($R^2 = 0.07$) and subpopulation ($R^2 = 0.05$) significantly explained variation in gut bacterial composition of polar bears at multiple bacterial taxonomic levels. Polar bears with pinniped DNA identified in fecal samples showed higher abundance of bacteria from classes Clostridia and Bacilli, and reduced abundance of Negativicutes. Fecal DNA metabarcoding can be a useful approach for identifying recent prey fed on by polar bears, complimenting relatively longer-term estimates from QFASA, and can aid in interpreting individual variation in the polar bear gut microbiome.

**COVID-19 and the SRKWs: A New Suite of Problems Facing the Critically Endangered Southern Resident Killer Whales in the Salish Sea**

Alanna Frayne¹, Erin Casellas², Taylor Shedd³

¹Soundwatch Boater Education Program, Friday Harbor, WA, ²Catalina Island Marine Institute, Broomfield, Colorado, ³Soundwatch - The Whale Museum, Friday Harbor, WA

Southern Resident Killer Whales (SRKW, *Orcinus orca*) may be found year-round in the Salish Sea. These killer whales comprise three matrilineal pods (J, K, and L) and were listed as Endangered under the Canadian *Species at Risk Act* in 2003 and under the United States *Endangered Species Act* in 2005 due to prey scarcity, vessel noise and disturbance, small population size, and exposure to toxins. Through federal, state and local regulations vessel disturbance has been mitigated by increased approach distances, reduced speeds, increased on-the-water enforcement, limitations of the number of commercial whale watching boats allowed to be with a group of whales at any one time, viewing time limits for commercial whale watching boats, and education. The ongoing COVID-19 (SARS-Cov-2) global pandemic's impact on daily life for most people has raised the question whether vessel traffic and disturbance accompanying the SRKWs would be reduced, which has been noted in marine mammals by other major global events that disrupt normal vessel traffic. However, recreational boating, which accounts for a majority of the violations against vessel regulations, has been deemed an appropriate form of social distancing in accordance with current guidelines. In the Salish Sea region, recreational vessel sales have seen a spike since the beginning of the pandemic, while commercial whale watching tours suffered from the lack of tourists. Despite the shift in tourism activities, Soundwatch found a net gain of vessels within ½ mile of SRKWs as well as a shift in the daily peak times of vessel disturbance in 2020. Outreach opportunities were severely limited due to the COVID-19 pandemic, likely a largely contributing factor to the adverse effects of the pandemic on the SRKWs. The reduction in commercial tourism activities did not provide a wide enough margin for recovery, deeming more efforts necessary to protect the SRKW population.

Sex and Maternal Kinship Drive Social Associations in Indo-Pacific Bottlenose Dolphins (*Tursiops aduncus*) in the Northern Egyptian Red Sea
Marc Fabrice Frei, Angela Ziltener
1University of Zurich; Dolphin Watch Alliance, Zurich, ZH, Switzerland, 2Dolphin Watch Alliance; University of Zurich - Department of Anthropology, Zurich, Zurich, Switzerland

Compared to male sociality and alliance formation, relatively little is known about sociality of female Indo-Pacific bottlenose dolphins (Tursiops aduncus). Kinship has been identified to be a driver of female-female associations. We assessed the dyadic association strengths depending on sex and maternal kinship. In mammals, females are generally said to be more philopatric than males. In Indo-Pacific bottlenose dolphins, conflicting statements have been made about sex-biased dispersal and philopatry. We have studied the Indo-Pacific bottlenose dolphins in the Northern Egyptian Red Sea for over a decade. We recorded the identities of the animals by photo-identification from the boat, supported by underwater photography during scuba diving or snorkelling. Maternal kinship was determined on a behavioural basis due to the prohibition of genetic sampling. The dyadic association strengths were determined by a social network analysis. To assess potential sex-biased dispersal/philopatry, we ran community detection algorithms at three frequently used reefs. Our results revealed that association strength depends on sex, with intersexual associations being weaker than intrasexual ones. We found evidence that females undergo strong bonds, especially with maternal kin. Neither females nor males could clearly be identified as being either the more philopatric or dispersing sex. The recurring female-female associations among the same individuals indicate that female sociality might be characterised by more stable relationships than previously thought. The strong bonds of related females are primarily explained by calf assistance and thus indirect fitness benefits for weaned daughters. This study expands our knowledge about the complex social system of Indo-Pacific bottlenose dolphins. The large bisexual distribution and lack of spatially restricted communities can be attributed to similar environmental conditions at the three examined reefs. These findings are of relevance for future conservation efforts: Rather than protecting single reefs, larger areas should be declared as marine protected areas with restricted and sustainable tourism.

Should I Stay or Should I Go? Effects of Thermal Disruption to a Primary Warm-water Refuge on Florida Manatees
Katy Frey1, Sheri Barton2, Kerri Scolardi1, Kristin Eaton1
1Mote Marine Laboratory, 2Mote Marine Laboratory, Sarasota, FL, 3Mote Marine Laboratory, Sarasota, Florida

Florida manatees (Trichechus manatus latirostris) are a threatened subspecies of the West Indian manatee that depends on warm-water refuges to survive the colder winter months. Manatees use a network of both primary (natural springs and power plant discharges) and secondary sites (typically thermal basins) to avoid cold-stress syndrome, which can ultimately be fatal. Based on the strong site fidelity patterns exhibited by manatees, disruptions to warm-water refuges, even temporary, could have detrimental effects on the individuals who rely on them. In 2018, the construction phase of the modernization of the Florida Power and Light (FPL) Lauderdale Plant commenced, temporarily disrupting the thermal discharge at one of two primary warm-water habitats in Broward County. Mote Marine Laboratory, in coordination with FPL, initiated a biological monitoring plan to study the impact of this shutdown on manatees. During the first three winters of the temporary shutdown, we used photo-identification to track distinct individuals’ movement patterns between the FPL Lauderdale Plant and other primary and secondary sites in Broward and Miami-Dade Counties. We coupled these observations with water temperature data to examine habitat selection within and among warm-water sites.
With the uncertain future of warm-water habitats, from retirement and modernization of power plants to water withdrawals and flow rate changes at natural springs, understanding manatees’ response to disruptions to their winter refuges is crucial for conserving an already vulnerable species.

Analysis of vocalization type and parameters of the Amazon River Dolphin (Inia geoffrensis) and the tucuxi (Sotalia fluviatilis)

Erin Frick¹, Hana Koilpillai², Olivia Felicia², Cassidy Frielings², Courtney Cryan¹, Kaitlyn Willgoths², Elias da Silva da Silva⁴, Suzanne Smith⁵

¹Eckerd College, Amazon River Dolphin Conservation Foundation, St. Petersburg, Florida, ²Eckerd College, ³Eckerd College, Millbury, Massachusetts, ⁴Amazon River Dolphin Conservation Foundation, Amazonia Expeditions, ⁵Amazon River Dolphin Conservation Foundation

Freshwater species such as the Amazon River dolphin (Inia geoffrensis) and tucuxi (Sotalia fluviatilis) are both endangered cetacean species that utilize acoustics signals as large components of their communication (i.e., whistles, clicks, burst pulse, etc.) similar to marine (i.e., oceanic) cetaceans. However, the vocal repertoire of both species are largely unknown, particularly in relation to establishing criteria to identify vocal type, acoustic parameters (such as duration, inter-click intervals, frequency, and amplitude), and relationship between acoustic signal use and environmental variables. The current study aims to contribute to our limited understanding of the Amazon River dolphin and tucuxi vocal repertoire using acoustic data collected by the Amazon River Dolphin Conservation Foundation along the Rio Negro in Ariaú, in the state of Amazonas of Brazil from 2016-2019. Dolphin sounds from both species (echolocation click trains, whistles, burst pulses, etc.) are manually identified using Raven Pro 1.6 spectrogram software. Vocalization types present for both species are categorized, with concomitant analyses for parameter variables for each vocalization type observed. For each sound type, we are analyzing the differences in sound production rate in relation to freshwater cetacean intra- and interspecies estimated group size, presence of other species (i.e., fish), and boat traffic. Results from this study not only contributes to our overall knowledge of the acoustic behavior and repertoire of these focal river dolphin species, but increases our understanding of the relationships between sound type and parameters with surrounding ecological variables. This research aims to successfully classify the dolphin sound types and to distinguish between I. geoffrensis and S. fluviatilis, to add to the limited literature available on river cetacean vocalizations.

Cetacean acoustic detection patterns off the remote coast of Gwaii Haanas in British Columbia, Canada

Heloise Frouin-Mouy¹, Xavier Mouy², James Pilkington³, Thomas Doniol-Valcroze⁴, Lynn Lee⁵

¹UCAR - CPAESS / NOAA-SEFSC, ²JASCO Applied Sciences Ltd, Victoria, ³Fisheries and Oceans Canada, Nanaimo, ⁴Fisheries and Oceans Canada, Nanaimo, British Columbia, ⁵Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site, Skidegate

To increase our limited knowledge of cetacean acoustic detection patterns in remote and difficult-to-access locations of the North Pacific Ocean, co-management partners of Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site – Council of the Haida Nation, Fisheries and Oceans Canada, and Parks Canada – have been deploying underwater passive acoustic recorders off the southern west coast of Haida Gwaii, British Columbia, Canada. We analyzed a 20-
month long (Sep 2009-May 2011) acoustic dataset recorded off SGGang Gwaay (52°02.02’N, 131° 12.05’W) and a two-year long (July 2017-July 2019) dataset recorded off Gowgaia Shelf (52°23.61’N, 131° 42.78’W). Results indicated acoustic presence and seasonal patterns of several cetacean species. Blue whales were acoustically present at both SGGang Gwaay and Gowgaia Shelf, with A-B vocalizations occurring every day from September to January. At both locations, fin whales were most acoustically common from September to March/April. At Gowgaia Shelf, humpback whale calls were detected every month of the year, but at SGGang Gwaay acoustic occurrence peaked only during winter when males were singing. Killer whale calls were sparsely detected, while sperm whale clicks were common at both locations through all months of the year with a notable decrease through winter. Cuvier’s beaked whale clicks and some potentially produced by Baird’s beaked whales, as well as porpoise clicks, were identified in high-frequency recordings from Gowgaia Shelf. Dolphin whistles occurred throughout with a decrease in winter and spring. Dolphin clicks seemed to follow a diel pattern, occurring more at night than during the day. Neither dolphin clicks nor whistles could be identified at SGGang Gwaay because of lower recording frequencies. Further analyses will include comparing acoustic detections with the available visual survey data and investigating the correlation of sea surface temperature and chlorophyll a to seasonal variability in cetacean acoustic detections.

Ance, and pollution are impacting marine environments globally. Human-associated phylotypes of *Escherichia coli*, an indicator of faecal contamination, have been found in aquatic environments and upper trophic marine mammals that are considered sentinels for marine health. Our objective was to analyse the presence and diversity of *E. coli* in three species of free-ranging pinniped pups in Australia. Faecal samples (*n*=963) were collected between 2016-2019 from Australian sea lion (*Neophoca cinerea*), Australian fur seal (*Arctocephalus pusillus doriferus*) and long-nosed fur seal (*Arctocephalus forsteri*) pups from eight breeding colonies along the Southern Australian coast. *E. coli* was isolated from 842 (87.3%) and assigned to phylotypes and subtypes. The human associated *E. coli* phylotype B2 was the most frequently isolated (73.7%) in all species. Phylo-type distribution did not differ significantly within or across species, breeding colonies or breeding seasons. Analysis of B2 sub-types showed a significant difference in distribution across breeding seasons at two colonies (Seal Rocks and Cape Gantheaume). The predominance of the B2 phylotype could indicate that all colonies are exposed to similar levels of anthropogenic pollution. The widespread occurrence of human-associated *E. coli* phylotypes highlights the imperative for ongoing monitoring and surveillance of microbes in both the marine environment and sentinel species.

**Widespread occurrence of human-associated Escherichia coli in free-ranging sea lion and fur seal pups in Australian waters**

Mariel Fulham¹, Michelle Power², Rachael Gray³

¹University of Sydney, Australia, ²Macquarie University, North Ryde, NSW, Australia, ³The University of Sydney, Camperdown NSW, Australia

**Fall distribution of cetaceans along the coast of southern and eastern Hokkaido, Japan**

Shiho Furumaki¹, Saki Shigematsu², Yuka Iwahara³, Yoko Mitani⁴

¹Hokkaido University, Japan, ²Hokkaido University, Hakodate, Japan, ³Hokkaido University, ⁴Kyoto University, Hokkaido, Japan

A variety of cetaceans are distributed along the coast of southern and eastern Hokkaido, from
Hidaka Bay (south), via the Doto area (east) to the Nemuro Strait, in fall. However, their distribution patterns and the factors affecting their distribution have not been clarified. This information is necessary for ecosystem management and marine conservation. The objective of this study was to clarify the distribution patterns and the environmental factors affecting the distribution of cetaceans in coastal Hokkaido. Visual surveys were conducted along the south and east coast of Hokkaido in September and October (2009, 2011-2021) by T/S Ushio-maru. Relationships between environmental variables (water depth, distance to land, slope, and sea surface temperature) and investigated using maximum entropy model models.

A total of 1102 sightings of five baleen whale species and seven toothed whale species was recorded during the study period. Most of baleen whales were sighted along the Pacific coast of eastern Hokkaido. Humpback whales (*Megaptera novaeangliae*) were distributed offshore area, which distribution pattern differed from that of their breeding and feeding areas, therefore they might use eastern Hokkaido as a corridor. Some species of toothed whales were widely distributed in the survey area and others were distributed in specific areas. For example, short-finned pilot whales (*Globicephala macrorhynchus*) were distributed only in Hidaka Bay, where the water temperature was high. They are thought to have migrated along the Pacific coast of Japan to forage with high temperature water masses during the summer season. Our study is the first effort to clarify the habitat of various whale species in the coastal Hokkaido and provide essential information for their conservation.

Panama bottlenose dolphin (*Tursiops truncatus*) whistles indicate less stress during COVID-19 pandemic

Emma Gagne¹, Betzi Perez², Andrew Hendry³, Gabriel Melo-Santos⁴, Sam F. Walmsley⁴, Manali Rege-Colt¹, Maia Austin¹, Laura J. May-Collado¹

¹University of Vermont, Burlington, VT; ²McGill University / Panacetacea, Panama, Panama; ³McGill University, Montreal, Quebec; ⁴Sea Mammal Research Unit - Scottish Oceans Institute - School of Biology - University of St Andrews UK, BioMA - Biology and Conservation of Amazonian Aquatic Mammals, St Andrews, Scotland, United Kingdom; ⁵Scottish Oceans Institute, St Andrews, United Kingdom

Energy-Mediated Responses to Changing Prey Size and Distribution in Marine Top Predator Movements and Population Dynamics

Cara Gallagher¹, Marianna Chimienti¹, Volker Grimm², Jacob Nabe-Nielsen³

¹University of Potsdam, Roskilde, Germany; ²Leipzig, Germany; ³Department of Bioscience, Aarhus University, Roskilde, Denmark
Climate change is rapidly modifying the structure of marine ecosystems, including that of fish communities. Changing environmental conditions can decrease fish size and modify community aggregation level ultimately impacting predators which rely on these communities. To assess the impacts of changes in prey size and aggregation level on a predator population, we applied an existing mechanistic model parameterized for harbor porpoises (Phocoena phocoena) which represents animal energetics and movements in high detail. We used this model to quantify effects of prey alterations on porpoise movement, space use, energetics, and population dynamics. Simulated porpoises increased their rates of switching from area-restricted search to transit behavior with increasing prey size, due to elevated rates of resource competition occurring in environments with larger prey and resultingly higher porpoise population abundance. However, movement impacts were not observed between tested prey distributions, owing to variations in prey encounter rates. Population decline occurred with decreasing prey size and aggregation level, with a 15% decrease in fish length resulting in population collapse regardless of prey spatial arrangement. However, population decline could be offset by increasing prey consumption rates by 44.2%. This increase was 15.2% higher than predicted by changes in food availability alone, providing evidence that mechanistic approaches which consider realistic animal movements and energetics can benefit investigations of the population consequences of changing prey availability, such as those predicted with climate change. The knowledge gained from these investigations can advance our understanding of the impacts of shifting environmental conditions on species and guide future conservation efforts in a changing world.

Five years of Antillean manatee stranding along the coast of Belize
Jamal Galves¹, Celeshia Guy²
¹Clearwater Marine Aquarium Research Institute, Cayo, Belize, ºClearwater Marine Aquarium Research Institute, Belmopan, Belize

Belize is a sacred home for the gentle creatures of the Caribbean Sea, particularly the Antillean manatee (Trichechus manatus manatus), a subspecies of the West Indian manatee. We are accredited as the country with the largest population of Antillean manatees throughout the wider Caribbean. Despite this fact, the population of manatees in Belize has been continuously facing a high mortality rate that can be directly connected to human behavior.

Five years of manatee stranding incidents reported by the Belize Marine Mammal Stranding Network were analyzed to understand the patterns of threats associated with this endangered population of the Antillean manatee (Trichechus manatus manatus). The information used in this analysis includes location and possible cause of stranding. A total of 156 stranding incidents was reported during the 5-year study. Seventy-one (N=156) percent of the incidents occurred within the Belize District, where the number of manatee strandings has almost tripled. Watercraft collisions accounted for the highest known cause of strandings with 42% (N=65) confirmed cases and is considered the leading cause of anthropogenic mortality for this population. This investigation identifies watercraft collisions as the leading threat to manatees in Belize. This finding of such high levels of manatee deaths in Belize is consistent with trends previously observed in Florida. Efforts should be made at curbing the increases in threats to the Antillean manatees of Belize. These findings emphasize the need for continued conservation actions to halt the increasing trend of manatees strandings. Other efforts must be guided by the findings to target the threat of watercraft by increasing awareness, stakeholder
partnerships, implementation of manatee legislations to protect this species. Boating regulations must be implemented within areas of high manatee stranding incidents such as the Belize River to reduce the threats to the species.

**Effects of changing temperature phenology on the local abundance of a critically endangered baleen whale**

Laura Ganley¹, Jarrett Byrnes², Daniel Pendleton¹, Kevin Friedland⁴, Jefferson Turner⁴, Charles Mayo⁵, Solange Brault⁶

¹Burlington, Massachusetts, ²University of Massachusetts, Boston, Boston, Ma, ³Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, Massachusetts, ⁴National Marine Fisheries Service, ⁵Center for Coastal Studies, Provincetown, Massachusetts, ⁶Boston, Massachusetts

Climate change is affecting the distribution of many marine species, changing their spatial interactions with anthropogenic activities, and in some cases posing severe risks for population viability. Accurate habitat-use predictions are necessary to anticipate where changes to conservation management are necessary to reduce these risks. Our goal was to identify the network of biological and environmental conditions causing variations in local right whale abundance in a habitat that has had a substantial increase in use over the past 10 years, and test for a spatial hierarchy of variables (basin-scale, regional, and local) that have cascading effects. We used Structural Equation Models to test for the effects of changing seasonal thermal cycles on the Gulf of Maine food web, and the impacts on local right whale abundance. Population size, zooplankton patchiness, the spring transition date, and regional *Calanus finmarchicus* density directly affected local right whale abundance. Cascading impacts of variations in the spring transition date resulted in years of earlier spring transition dates with higher local right whale abundance. Structural Equation Models are a powerful tool that can identify mechanistic drivers and therefore are valuable for studying climate change impacts on ecosystems. Testing spring transition date within a system of interconnected ecosystem variables highlighted the complexity of attempting to predict changes in wildlife distributions under climate change when the cascading effects may differentially impact many of the variables within the network.

**Characteristics of Wild Florida Manatee (Trichechus manatus latirostris) Vocalizations in Different Sized Groups**

Emily Garcia¹, Athena Rycyk²

¹New College of Florida, Sarasota, FL, ²New College of Florida, Sarasota, Florida

Although Florida manatees (*Trichechus manatus latirostris*) lack a defined social structure, manatees are commonly gregarious. They produce generally tonal, short vocalizations that can vary in structure and temporal characteristics based on age, sex, and activity. We compared frequency and temporal characteristics of vocalizations produced by manatees found alone or in groups of various sizes. Vocalizations were recorded by digital acoustic tags deployed on wild manatees in Florida. Eleven tagged manatees and nearby manatee conspecifics were recorded in the region between Sarasota Bay and Pine Island Sound. High-quality vocalizations (n=225) with a minimum signal to noise ratio of ≥3dB were characterized and grouped by vocalization type. Group size ranged from one to nine manatees. Differences in vocalization types and characteristics between groups sizes are discussed. These findings expand our understanding of Florida manatee vocal behavior and the factors that influence it.
From Tourism to Genetics: a Population Evaluation of Provisioned Botos (Inia geoffrensis - Cetacea: Iniidae) in Negro River, Central Amazon
Ellen Garcia1, Waleska Gravena1, M. F. da Silva Vera2, Mateus Ferreira2
1National Institute for Amazonian Research, Manaus, AM, Brazil, 2Aquatic Mammals Laboratory (LMA), National Institute of Amazonian Research, Manaus, Amazonas, Brazil

Wild Botos have formed aggregations in touristic floating houses in the Negro River for over 20 years. The degree of genetic differentiation between aggregations and how these animals relate to other natural populations are still unknown. Therefore, this study aimed to investigate the genetic structure of the touristic aggregations of Inia geoffrensis, in addition to patterns of genetic connectivity between different populations of the Amazonas, Orinoco and Araguaia-Tocantins basins. In total, 75 individuals were sampled on seven touristic floating houses. Molecular analyzes addressing the regional (macro) and local (micro) scales were performed using the mitochondrial D-loop gene (387 base pairs) and nuclear sexual markers. No genetic differentiation was detected between touristic aggregations, with high migration rates being estimated. The aggregation of Novo Airão showed the lowest number of migrants, in addition to low levels of genetic diversity, the opposite being observed for the other aggregations. All individuals collected on the touristic floating houses are male. The results of the Bayesian cluster analysis showed that the populations of the Bolivian Amazon (Inia boliviensis), Araguaia (Inia araguaiaensis) and Orinoco basin (Inia geoffrensis humboldtiana) make up highly structured clusters. The central-western Amazon region is structured due to the greater proportion of certain clusters. The lower Negro River has one cluster being exclusive, one predominant in this region and in the Balbina reserve, and two other that are found more frequently in other regions. The social organization of the Botos and the hydrographic location of the aggregations can be decisive for the absence of females. In the macro-scale analyzes, the lower Negro River is the most heterogeneous region for composing about half of the proposed clusters. Furthermore, the absence of genetic differentiation between the touristic aggregations of Botos seems to correspond to the variable environment that this portion of the lower Negro River represents.

Mercury contamination in critically endangered Rice’s whales (Balaenoptera ricei sp nov) and their prey in the Gulf of Mexico
Laura Garcia Barcia1, Jeremy Kiszka2, Lance Garrison3
1Florida Internatiional University, Aventura, Florida, 2Florida International University, North Miami, Florida, 3Miami, FL

Recently described Rice’s whales (Balaenoptera ricei sp nov) have a restricted distribution in the northeastern Gulf of Mexico, and are considered as Critically Endangered by the IUCN due to their low abundance (51 individuals, CV=0.50) and limited range. Rice’s whales are potentially exposed to a range of threats, including vessel collision, noise, and chemical pollution. Efforts to document threats are critical to properly identify priority conservation actions and to mitigate impacts from human activities. In this study, skin samples from 10 individual Rice’s whales were collected and analyzed for total mercury (AFS), methylmercury (CV-AFS) and selenium concentrations (ICPMS). In addition, total mercury concentrations and stable isotope ratios were analyzed for prey species. Total mercury and selenium levels averaged 0.14 ±0.05 µg THg /g dry weight and 8.74 ±3.53 µg Se/g dry weight. Selenium Health Benefit values were positive for all individuals (110.69 ±44.73), indicating no negative health impacts from mercury accumulation. Methylmercury levels in whale tissue were non-detectable. Prey items averaged 0.1 ±0.05, 0.12 ±0.14, 0.36 ±0.63, 2.69
±6.06 µg THg/g dry weight for *Ariomma bondi*, *Diaphus dumerilii*, *Doryteuthis pealeii* and *Maurolicus weitzmani*, respectively. Mercury biomagnification from prey was non-detectable when dietary contributions from all prey items were taken into account (BMF_psc= 0.42). Overall, mercury accumulation in Rice’s whale were very low and comparable to the concentrations found in other species of baleen whales worldwide. While mercury concentrations may pose a threat to other marine fauna, it is not a conservation concern for Rice’s whales.

**Habitat use of common bottlenose dolphins (Tursiops truncatus) from the coastal waters in the southwestern Gulf of Mexico**

Pamela Garcia-Aguilar¹, Eduardo Morteo², Christian Delfín-Alfonso², Ibiza Martínez-Serrano³, Gerardo Castro-Bobadilla⁴

¹Universidad Veracruzana, Xalapa, Veracruz, Mexico, ²Instituto de Investigaciones Biológicas, Universidad Veracruzana, Xalapa, Veracruz, Mexico, ³Universidad Veracruzana, Xalapa Veracruz, Mexico, ⁴Facultad de Biología, Universidad Veracruzana, Xalapa-Enríquez, Veracruz, Mexico

Habitat use refers to the activities that a species or population performs in its environment. We studied a 109km² area in the coastal waters of Alvarado within two periods (2006-2010, 2016-2019) to determine the density of bottlenose dolphins, their activities, and their temporal changes. We accomplished 95 surveys between 8:00AM 16:00PM, to record group location and behavior (feeding, traveling, playing, resting, evasion, wandering, interaction with boats and socializing). Spatial models (adaptive kernel 50, 75, 95%) were used to identify the sites with higher use and their overlapping distribution. There were not monthly or annually differences in the frequency or proportion of behaviors from the 322 registered schools, but the number of sightings showed a gaussian distribution throughout the day, with higher feeding frequency during the morning, decreasing at noon, and increasing again towards the afternoon; this pattern was inversely proportional to traveling and evasion. Density varied from 0.1-3.1 sightings km⁻² without significant temporal differences, and the used area declined from 80-30 km² between 2006-2018, but this trend was not significant. The most common activities were feeding (28%), evasion (22%) and traveling (18%), with core areas of 9, 27 and 31 km², respectively. The areas for traveling-evasion had a high degree of overlap compared to feeding-traveling and feeding-evasion. The mouth of the Alvarado lagoon system works as an attraction pole for dolphins mainly for feeding activities, which confirms its importance as key habitat for the conservation of this species. The broad influence of the continental waters has an integrative effect in the distribution of dolphin’s activities within this small area, but we found evidence of exclusion sites for specific behaviors (i.e. avoidance).

**Changes in the migration timing of humpback whales (Megaptera novaeangliae) and sea surface temperature in the Babuyan Marine Corridor, northern Luzon, Philippines**

Timothy Gardner¹, Jo Marie Acebes², Elson Aca³, Takeya Sakamoto⁴, Angelico Tiongson⁵, Shotaro Nakagun⁶

¹BALYENA.ORG, Worcester, MA, ²BALYENA.ORG, Marikina City, Philippines, ³BALYENA.ORG, Jagna, Bohol, Philippines, ⁴Osaka, Osaka, Japan, ⁵Institute of Environmental and Marine Sciences, Silliman University, Dumaguete, Philippines, ⁶Obihiro University of Agriculture and Veterinary Medicine, Obihiro, Hokkaido, Japan

Humpback whales (*Megaptera novaeangliae*) undergo long migrations from higher latitude feeding grounds in the summer to lower latitude breeding grounds in the winter in oceans worldwide. While the International Union for
Conservation of Nature (IUCN) currently categorizes humpback whales as Least Concern globally, small, discrete subpopulations are still potentially at risk. The United States National Marine Fisheries Service recently defined 14 distinct population segments (DPS) of humpback whale populations and classified the western North Pacific DPS of humpback whales as Endangered, which includes humpback whales that winter in the northern Philippines. Surveys have been conducted to collect sightings and photo-identification data in the Babuyan Marine Corridor, northern Luzon, Philippines since 2000, with survey effort overall concentrated between March and April. Various role types of humpback whale are typically encountered, with high-energy competitive groups (CGs) generally encountered at the beginning of the survey (early March) and mom-calf pairs (MCs) being associated with the end (mid to late April). Comparisons of the average last sighted dates (LSDs) from 2004-2008 and 2015-2019 indicate that CG LSDs have shifted earlier by approximately one month and disappeared entirely from the record after 2015. Conversely, average MC LSDs have overall increased by almost a week over the same time period. An analysis of local sea surface temperature (SST) change over time suggests that increases in local March and April SST influences humpback whale LSDs but that these changes do not seem to be the primary driver of observed changes in LSDs. Further investigation into other potential factors, including El Niño-Southern Oscillation occurrence and strength, associated feeding ground primary productivity, and SST at larger spatial and temporal scales is warranted to better understand and predict when this Endangered humpback whale DPS is undergoing its crucial yearly migration and utilizing sensitive breeding ground habitat.

Global cultural evolutionary model of humpback whale song evolution, revolution and transmission

Elisabeth Zandberg¹, Robert F. Lachlan¹, Luca Lamoni², Ellen Garland³
¹Royal Holloway University of London, Egham, United Kingdom, ²University of St. Andrews, St. Andrews, Fife, United Kingdom, ³University of St. Andrews, United Kingdom

Humpback whale song is a striking example of vocal cultural behaviour. Males within a population adhere to a common song type, which slowly evolves over time. In Northern Hemisphere populations, the complex songs show long-lasting traditions that slowly evolve, while in the South Pacific, periodic revolutions also occur when songs are adopted from neighbouring populations and rapidly spread. The mechanisms underlying these patterns of cultural evolution and transmission are not clearly understood. Here, we used individual-based cultural evolutionary models of the entire Southern and Northern Hemisphere humpback whale populations in combination with empirical data to infer processes of vocal learning and cultural evolution. We simulated processes of song innovation, biases in song learning and patterns of contact among populations. We compared our model outcomes with patterns of song theme sharing measured in South Pacific populations using Approximate Bayesian Computation to infer the parameter values most consistent with this data. We found that low levels of mutation in combination with rare population interactions were sufficient to closely fit the pattern of song sharing in the South Pacific, including the distinctive pattern of West-to-East revolutions. The same learning parameters that gave rise to revolutions in the Southern Hemisphere simulations also gave rise to evolutionary patterns of cultural evolution in the Northern Hemisphere populations. This study demonstrates how cultural evolutionary approaches can be used to make inferences about the processes underlying vocal learning and cultural transmission.
Assessing views and capabilities of emergency response practitioners toward preparedness for wildlife response and conservation initiatives during disasters

Mendy Garron, NOAA National Marine Fisheries Service

Many wildlife species are vulnerable to impacts from hundreds of natural and anthropogenic disasters that occur globally on an annual basis. Response to wildlife during a disaster can vary worldwide from local levels to international responses. Furthermore, emergency response infrastructure varies across geographic regions, and priorities specific to wildlife responses and conservation monitoring are even more variable within and across infrastructures. The views of emergency response practitioners toward preparedness for wildlife response during disasters are likely to influence how conservation challenges are addressed during disaster responses. This exploratory study examined the views and capabilities of emergency response practitioners toward preparedness for wildlife response and conservation initiatives during disasters. A structured survey method was used to survey members of the International Association of Emergency Managers (IAEM) and employees of state and federal emergency management agencies. The Animal and Human Solidarity Measure (Amiot and Bastian, 2017), the Wildlife Value Orientation Scale (Fulton, Manfredo, and Lipscomb, 1996), and additional Likert-scale survey questions were used to assess wildlife views, along with collection of relevant demographic data. Quantitative data analysis was performed to explore relationships between wildlife priorities and emergency response decision-making. The results of this study can impact contingency planning and conservation programs by integrating identified wildlife views and resource needs into planning efforts by emergency response entities. The need for this type of data is increasing to mitigate climate change impacts on wildlife and biodiversity, and results can benefit global emergency response professionals as well as wildlife research and conservation communities.

Measuring mercury in vibrissae of Steller sea lions as a novel approach at understanding multi-year fluctuations in mercury intake

Angela Gastaldi1, Lorrie Rea2, Amy Bishop3
1University of Alaska Fairbanks, Fairbanks, Alaska (AK), 2University of Alaska Fairbanks, Fairbanks, Alaska, 3University of Alaska Fairbanks

Studies of mercury in pinnipeds generally use tissues such as blood and fur, which provide researchers a glimpse at mercury concentrations in the animal reflecting a brief time period. While helpful for health monitoring, this limits assessment of contaminant transport through marine food webs and potential impact of bioaccumulation on populations. Steller sea lion (SSL) vibrissae are grown continuously and have been used to explore intra-annual and multiyear patterns in foraging, and may provide an opportunity to understand multi-year fluctuations in mercury consumption. In this study, we (1) investigated the feasibility of measuring total mercury concentrations ([THg]) from SSL whiskers, (2) characterized the changes in mercury along the length of the whisker, and (3) assessed the reliability and repeatability of measurements. To verify the minimum section length that could be used to obtain an accurate [THg] measurement, two whiskers each were sectioned and analyzed from an adult female and a pup using section lengths of 0.1cm and 0.2cm. It was determined that for both age classes, an accurate [THg] measurement could be obtained from a 0.2cm whisker section, although the whiskers become thin near the tip and may require use of longer segments. Comparison of [THg] among whiskers from the same individuals showed that mercury is deposited at similar rates in each whisker, although sections near the root and tip of the whiskers show less agreement. Based on prior published growth
rates of SSL vibrissae, a 0.2cm section represents about two weeks of growth in an adult SSL and about 5 days of growth in an SSL pup. The results from this study aid in the development of future research analyzing mercury in vibrissae sections that were sectioned and archived during previous SSL diet modeling studies.

**Molecular Adaptations to Deep Diving and Aquatic Life in Phocid Seals**

*Stephen Gaughran¹, Adalgisa Caccone², George Amato³, Jeffrey Townsend², Etowah Adams²*

¹Princeton University, Princeton, NJ, ²Yale University, New Haven, CT, ³Sackler Institute for Comparative Genomics, New York

Species of phocid seals have many morphological and physiological adaptations to general marine life, with each lineage exhibiting further adaptations to particular environments and life histories. In this study, we analyze dozens of re-sequenced seal genomes to identify more than 100 genes underlying adaptations across five phocid seal lineages (Weddell seals, elephant seals, monk seals, grey seals, and ringed seals). We use a newly developed statistical model to quantify the intensity of selection at each site across a gene, and focus on genes putatively related to adaptive phenotypes in seals. These phenotypes include thermal adaptations to tropical or polar waters, the development of an insulating and energy-rich blubber layer, and physiological adaptations to hypoxia and deep diving. No genes related to tropical adaptations showed positive selection in the monk seals. However, we find that all five lineages show positive selection in genes associated with a thick blubber layer, with collagen genes especially overrepresented in the set of positively selected genes. This ubiquitous signal suggests that the repurposing of mammalian collagen genes in the blubber layer is an ongoing and complex adaptive walk, possibly driven by trade-offs in selective pressures. The elephant seals, which are the most extreme pinniped divers, show strong positive selection in genes relating to cardiac muscle function and heart rate regulation. Physiological changes in the heart, including induced bradycardia, have been proposed as important adaptations to hypoxia in deep-diving seals, and our results suggest that these changes are driven by a suite of amino-acid adaptations in several key genes. The identification of these positively selected genes makes clear that adaptive protein evolution underlies many of the remarkable adaptations in seals, which opens the door for more targeted studies of functional molecular adaptations in marine mammals.

**Signature whistles of bottlenose dolphins (Tursiops truncatus) in the Cedar Keys, Florida**

*Jolinde Vlaeyen¹, Becca Hamilton², Stefanie Gazda³*

¹Utrecht University, VOORBURG, Netherlands, ²University of Manchester, United Kingdom, ³University of Florida, Newberry, Florida

Communication in the animal kingdom is crucial for social species. Bottlenose dolphins (*Tursiops truncatus*) are a social species that live in highly fluid and dynamic fission-fusion societies. Dolphins are extremely vocal species and use a wide acoustic repertoire, consisting mostly of signature whistles. Such whistles are unique to the individual and are thought important for social interactions and maintaining group cohesion. Finding signature whistles in each dolphin population is important to understand more about their behaviours. The dolphin population in the Cedar Keys, Florida, USA, uses a specialized foraging tactic called driver-barrier feeding, which is the first foraging tactic seen in marine mammals that involves a division of labour with role specialization. Previous research suggests it is a highly cooperative foraging strategy, and vocal communication may play a role in coordinating such foraging behaviours. However, analysis of signature whistles for this
dolphin population is currently lacking. As such, this baseline study analysed existing data for possible signature whistles, collected in 2018 and 2019. To date, 11 potential signature whistles have been identified using the SIGID method from 36 individuals present during recordings of foraging activity. Thus, successful identification of these candidate signature whistles is an important step towards better understanding the communication, behaviours, and social interactions of this population. Future directions for this work include analysing more encounters to find additional signature whistles, with the potential of matching signature whistles to each individual, identifying vocalizing individuals. **Keywords:** signature whistle, bottlenose dolphin, Tursiops truncatus, SIGID, driver-barrier foraging

**The longest recorded movement of a common bottlenose dolphin (Tursiops truncatus) in the Mediterranean Sea: why paying attention at online meetings matters**

Tilen Genov¹, Jure Zeleznik², Bruno Chiara³, Monica Francesca Blasi¹
¹Morigenos - Slovenian Marine Mammal Society, Portorož, Slovenia, ²Morigenos, Piran, Slovenia, ³Filicudi WildLife Conservation, Lipari, Messina, Italy

Information on movements and connectivity among populations of animals is important for the delineation of units to conserve, so that other types of information, such as abundance, fecundity and mortality, can be placed in an appropriate population and conservation context. Common bottlenose dolphins (Tursiops truncatus) in the Mediterranean Sea are often considered relatively ‘resident’ and demonstrating strong site fidelity to specific areas. However, this perception may partly be an artefact of the distribution and ‘habitat use’ of cetacean researchers, rather than animals themselves, and bottlenose dolphins have been shown to be capable of substantial movements, often in relatively short periods of time. Here, we report on a long-distance movement of a bottlenose dolphin, discovered by spotting a known fin in a presentation during an online scientific meeting. The matched dolphin moved across the Tyrrhenian, Ionian and Adriatic Seas, making this the longest recorded movement for this species in the Mediterranean Sea to date and one of the longest in the world. We also review published records of long-distance movements in this species worldwide. This study underscores the utility of photo-ID and the importance of regional data sharing. Photo-ID comparisons are always worth a shot, as we never know what interesting results we may find.

**Strength and quality of social bonds predict direct fitness in bottlenose dolphins**

Livia Gerber¹, Richard Connor², Simon Allen³, Kay Horlacher³, Stephanie King⁴, William Sherwin⁵, Erik Willems⁶, Samuel Wittwer⁷, Michael Krützen⁶
¹University of Zurich, Switzerland, ²University of Massachusetts Dartmouth, North Dartmouth, Massachusetts, ³University of Bristol, Bristol, United Kingdom, ⁴University of Bristol, Bristol, United Kingdom, ⁵University of New South Wales, Sydney, Australia, ⁶University of Zurich, Zurich, Switzerland, ⁷University of Zurich, Zürich, Zürich, Switzerland

Variation in reproductive success, or fitness, evident between individuals has been linked to differences in physical attributes as well as social bond strength. Many studies have investigated the link between social bonds and fitness in females but much less is known of males. This is of particular interest in species where unrelated males cooperate to gain access to females. Adult male Indo-Pacific bottlenose dolphins form multi-level alliances, engaging in coordinated efforts to compete with rival alliances over females. The core social unit is the second-order alliance, comprised of 4-14 males. Nested within these second-order alliances, two to three males
form first-order alliances, which can vary in composition, to sequester individual females within ‘consortships’. Here, we combined genomic and behavioural data on 83 members of eleven second-order alliances to assess the influence of individual node strength (weighted degree centrality), variability in social bond strength across the second-order alliance, first-order alliance stability, home range size, and age similarity on male fitness. Using a Bayesian approach, we identified social bond strength as the only significant predictor of the number of paternities and thus, direct fitness. In addition, we found a strong effect of variation in social bond strength with males having more homogenous social bonds to second-order allies obtaining more paternities. The fitness of male bottlenose dolphins is therefore influenced by an individual’s access to close and reliable social partners with whom to cooperate as is the case in some highly encephalised terrestrial species such as our own.

Franciscana dolphin (*Pontoporia blainvillei*) is the most affected dolphin species in the Southwestern Atlantic Ocean. It is classified as Vulnerable A3D by IUCN and SAREM (national level) and only in northern coast of Argentina (Buenos Aires Province) around 400 dolphins are entangled every year in coastal gillnets. However, until now little is known about the operation of Franciscana echolocation systems during entanglements, so more studies need to be carried out to improve possible conservation solutions. Passive acoustics could be a good tool to study the presence of Franciscana in a given area. Franciscana is characterized by a cryptic behavior and it is known to produce narrowband high-frequency (NBHF) pulsed signals with a peak frequency of 130kHz which may be lower in juveniles and calves. Therefore, two passive acoustic loggers (F-PODs; Chelonia Limited) were deployed 100 m apart to record cetacean activity in a marine coastal area of Buenos Aires Province with the aims of studying the acoustic presence of the Franciscana dolphins and to identify possible circadian rhythms in relation with environmental variables. Two acoustic detectors was located at a depth of between 5 and 7 meters during the summer months of 2020 and 2021. We collected a total of 1485 hours of recordings. On 29% of the days recorded, we detected high frequency and narrow band click trains compatible with those emitted by the Franciscana dolphins. Positive detection of NBHF clicks showed a significant relationship with atmospheric pressure, temperature, and the percentage of bottom sediments noise. However, no hourly preference patterns were evidenced, as well as the solar inclination associated with underwater luminosity. These first results show us the potential importance of passive acoustics as a complementary tool to improve conservation regulations of this Vulnerable dolphin.
Acoustic presence of baleen whales in the North Atlantic; a case study using the humpback whale (Megaptera novaeangliae).

Cathy Gibson¹, Denise Risch², Suzanne Beck³, Jonathan Houghton⁴, Nienke van Geel⁵, Ewan Edwards⁶, Kate Brookes⁷

¹Queen’s University Belfast, Agri-Food and Biosciences Institute, Newtownards, Northern Ireland, United Kingdom, ²Scottish Association for Marine Science, Dunbeg, United Kingdom, ³Agri-Food & Biosciences Institute, Belfast, United Kingdom, ⁴Queen’s University Belfast, Belfast, United Kingdom, ⁵Scottish Association for Marine Science, Oban, Argyll and Bute, United Kingdom, ⁶Marine Scotland Science, Aberdeen, Scotland, United Kingdom, ⁷Marine Scotland Science, Aberdeen, United Kingdom

This PhD contains four hypotheses centered on the use of acoustics as a tool for baleen whale conservation and ecosystem management: (1) There is a distinct seasonal pattern in baleen whale presence in NI/Scottish waters which can be effectively monitored through passive acoustics; (2) Timings of detections across baleen whale breeding locations can be used to reveal/confirm potential migratory patterns; (3) The spectral characteristics of humpback whale song recorded in NI/Scottish waters are significantly different to those in other North Atlantic locations; (4) Through a spatial representation of data, it is possible to highlight regions of risk for baleen whales in local waters. The first chapter is focusing on the seasonal presence of baleen whales in Scottish and Northern Irish waters, building upon a preliminary assessment of humpback whale acoustic behaviour in the NE Atlantic. Chapter two is exploring the timings of humpback whale song across the North Atlantic to build and ocean basin scale understanding of humpback whale migrations by comparing the timing of acoustic detections. Chapter three aims to investigate differences in song structure of humpback whales from breeding grounds across the North Atlantic. Chapter four is intended to have an applied management and marine spatial planning focus in local Northern Irish waters with the aim to explore potential overlaps of baleen whale occurrence with specific human activities that are considered key threats.

How do Fin Whales Protect Their Respiratory Tract While Swallowing Massive Quantities of Food Underwater?

Kelsey Gil¹, A. Wayne Vogl¹, Robert Shadwick³

¹University of British Columbia, ²University of British Columbia, Vancouver, B.C., ³University of British Columbia, Vancouver

Digestive and respiratory pathways are entwined evolutionarily, developmentally, and spatially. The pharynx is the crossroads of these tracts, residing behind the nasal and oral cavities and containing the larynx. The pharynx balances breathing and swallowing, allowing food transfer while maintaining airway protection. Cetaceans have terrestrial ancestry, thus, a terrestrial framework that required modifications for life underwater. Toothed whales have a permanently intranarial tubular larynx, completely separating respiratory and digestive tracts to facilitate echolocation. Rorqual baleen whales do not echolocate, but have many adaptations related to feeding, which involves engulfing a volume of prey-laden water that can be larger than their own body. Laryngeal morphology in rorquals differs vastly from odontocetes, with a splayed open laryngeal inlet and no tubular structure. Considering the immense amounts of tiny living prey collected during each lunge, I asked: how are the pharynx and larynx adapted to maintain protection during swallowing? I explored this question with dissections of adult and fetal fin whales to reveal pharyngeal and laryngeal structures. I dissected a dolphin fetus as a representative odontocete. The pharyngeal and laryngeal positions in fin whales during deglutition are surprisingly similar to a terrestrial carnivore, with the exception of a novel structure discovered in rorquals, the oral plug, that
passively protects the pharynx from water incursion during lunging. The lower airways are protected by completely sealing the larynx and trachea through passive and active mechanisms. The upper airways are completely sealed by the soft palate and oral plug. Rorquals have maximized feeding ability by dedicating the entire pharynx to the digestive tract during swallowing, an adaptation that has contributed to rorquals becoming the largest animals ever to have lived.

Recent spatial and temporal shifts on cetacean distribution in the Portuguese Continental Economic Exclusive Zone

AGATHA GIL1, Mafalda Correia2, Raul Valente3, Cláudia Rodrigues4, Isabel Sousa-Pinto5, Edna Cabecinha6, Graham J Pierce7

1UTAD, CIIMAR, CSIC, Porto, Cedofeita, Portugal, 2VAT# PT501413197 Universidade do Porto - Faculdade de Ciências, Porto, Portugal, 3Faculty of Sciences, University of Porto, CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, Porto, Portugal, 4Interdisciplinary Centre of Marine and Environmental Research (CIIMAR-UP), VAT: PT508792657. LO#258457, Matosinhos, Portugal, 5Interdisciplinary Centre of Marine and Environmental Research (CIIMAR), Matosinhos, Porto, Portugal, 6Department of Biology and Environment, Centre for the Research and Technology of Agro-Environmental and Biological Sciences (CITAB), University of Tras-os-Montes and Alto Douro, Vila Real, Portugal, 7Instituto de Investigaciones Marinas, Baiona, Pontevedra, Spain

With long-term implications for ocean health and biodiversity conservation, climate change is a global and urgent challenge. In the last few decades, the pressure on marine biodiversity and on the conservation status of marine species, caused by ocean climate-related changes, has been attracting considerable attention. As top predators, cetaceans play a key role in the balance of the dynamic marine ecosystems and are highly susceptible to changes in the environment (e.g. due temperature changes in relation to their thermal niche as well as changes in prey distribution). This, coupled with their high public profile, makes them suitable indicators of climate-driven impacts. Within this work, we aimed at examining evidence for recent shifts in distribution patterns of cetaceans and their relationships with changes in the sea-surface temperature (SST). We focused on the Portuguese Continental Economic Exclusive Zone using the CETUS Project data, spanning from 2012 to 2019. CETUS is a cetacean monitoring programme using large vessels as platforms of opportunity to survey long-transect routes within the Eastern North Atlantic. Cetacean occurrence data analysed included 963 sightings collected on ~ 55,000 km of survey effort. The sampled area ranged from coastal to oceanic waters and from 34°N to 41°N latitudes. For a descriptive and trend analysis of spatial and temporal distribution patterns, species were grouped in ecological guilds. To test the influence of SST on cetacean occurrence, Generalized Additive Models (GAMs) were developed for the most frequently sighted taxa, representative of the main guilds: *Delphinus delphis*, Ziphiidae and *Balaenoptera acutorostrata*.

The analysis revealed latitudinal shifts in the distribution of dolphin species over time, with the range apparently shifting towards northern latitudes within study area. Future work will be focused on predicting cetacean distribution under future climate change scenarios, and including other climate-related variables, to support efficient cetacean conservation and marine management.
Cetaceans release nutrients in the photic zone: large-scale estimates from contrasted ecosystems highlight the relative contributions of different ecological groups

Lola Gilbert1, Jérôme Spitz2, Tiphanie Jeanniard-du-Dot3, Matthieu Authier4, Tiphanie Chouvelon5

1Centre of Biological studies of Chizé (CEBC), University of La Rochelle, Sainte Marie de Ré, France, 2Observatoire Pelagis UMS 3462 LRUniv - CNRS, La Rochelle, Nouvelle-Aquitaine, France, 3Centre d’Etudes Biologiques de Chize - CNRS, Villiers en Bois, France, 4Observatoire Pelagis UMS 3462 LRUniv - CNRS, La Rochelle, Nouvelle Aquitaine, France, 5Observatoire Pelagis UMS 3462 LRUniv - CNRS, La Rochelle, France

Nutrient fluxes are crucial to ocean productivity. Phytoplankton growth relies on the availability of essential nutrients, and cetaceans could contribute significantly to the primary production dynamics by releasing nutrient-rich fecal matter in the photic zone. However, the relative role of species within the cetacean community and between ecosystems has never been estimated. Here, we used a bioenergetic model set up with abundance data from broad-scale multispecies surveys, diet composition and nutrient concentrations in prey to estimate the amount of nutrients released by cetaceans, from large whales to small delphinids. We applied our approach on contrasted ecosystems worldwide (temperate and tropical, oligotrophic and eutrophic), considering both macronutrients (Nitrogen, Phosphorous) and micronutrients (iron, cobalt, copper, zinc, selenium, …). We showed the quantity and the relative composition of nutrients excretion vary with the species composition of the cetacean community. In some areas, small delphinids contribute to the release of greater amounts of nutrients into the photic zone than baleen whales. The relative contribution of different nutrients is then shaped by the diet of cetacean ecological groups; for example, deep divers are the major contributors to the release of copper, an element found in high concentration in cephalopods. Finally, the difference in nutrient excretion densities by cetaceans (expressed in tons/km²) could be related to ecosystem productivity. For instance, nitrogen excretion density is eight times higher in the eutrophic Northeastern Atlantic than in the oligotrophic Mediterranean Sea. Our study provides the first broad scale quantifications of nutrients released by cetaceans and suggests contrasted implications for fertilization, phytoplankton growth and carbon sequestration between ecosystems. The value of cetacean conservation takes on new dimension for the health and resilience of ocean ecosystems through the perspectives of Blue Carbon and Natural Biological Solutions to climate change.

Novel method to estimate anthropogenic noise effects on marine mammals and evaluate mitigation effectiveness: a case study on endangered southern resident killer whales

Marianne Gilbert1, Alejandro Buren2, Dominic Tollit3, Amy Johnson4, Jason Wood5, Alexander MacGillivray6, Kevin Akaoka7, Deborah Lacroix7


We developed a flexible agent-based model to assess effects of anthropogenic underwater noise on marine mammals. The method uses information on movement of animals through an area and modelled acoustic footprints to estimate potential effects to exposed individuals. The model is implemented in a Monte Carlo simulation framework to assess uncertainty and allows the testing of different mitigation options to evaluate their potential effectiveness in reducing acoustic effects. We applied this method to assess potential acoustic effects on
endangered southern resident killer whales (*Orcinus orca*) from construction and operation of a proposed container terminal project in British Columbia, Canada. We relied on effort-corrected sightings data and species-specific behavioural disturbance thresholds based on previously developed dual dose-response curves to estimate potential lost foraging time (and 95% confidence intervals) due to underwater noise from anticipated terminal activities. We used the simulation model to estimate the spatiotemporal overlap between killer whale transits and the acoustic footprints for various terminal activities, including sound sources that are both stationary (e.g., dredging, piling) and mobile (e.g., vessel movements). For construction, we estimated the effectiveness of different mitigation options relying on marine mammal observers (considering sighting conditions-specific detection functions) and passive acoustic monitoring. We found that implementing both detection methods in addition to changes in the timing of noisy activities to avoid peak use by killer whales resulted in 87% reduction in estimated potential lost foraging time. The method allowed us to evaluate the effectiveness of the mitigation options, conduct sensitivity analysis of key inputs, and inform proposed project mitigation measures. This novel method offers the flexibility to be adapted and applied to other activities, locations, and species.

New insights into kinship, social dynamics and phylogeography in the most socially dimorphic species of the marine realm: the sperm whale (*Physeter macrocephalus*).

**Justine Girardet¹,** François Sarano², Gaëtan Richard³, Paul Tixier⁴, Christophe Guinet⁵, Veronique Sarano⁶, Hugues Vitry⁷, Axel Preud'homme⁸, Ana M Garcia Cegarra⁹, Hervé Glotin⁴, René Heuzey¹⁰, Olivier Adam¹¹, Bénédicte Madon¹², Alana Alexander¹³, Jean-Luc Jung¹⁴

¹*Museum d'histoire naturelle, Brest, France,* ²*Valence, France,* ³*ENSTA Bretagne, Brest,* ⁴*Deakin University, Geelong, Victoria, Australia,* ⁵*Centre d’Etudes Biologiques de Chizé (CEBC), Chize, France,* ⁶*Association Longitude 181, Valence, France,* ⁷*Marine Megafauna Conservation Organisation (MMCO), Mauritius,* ⁸*Marseille, France,* ⁹*CIFAMAC Chile,* ¹⁰*Label Bleu production,* ¹¹*Sorbonne Université, CNRS, Institut Jean Le Rond d’Alembert, F-75005 Paris, France,* ¹²*Paris, France,* ¹³*Université de Bretagne Occidentale, Brest,* ¹⁴*University of Otago,* ¹⁵*BioGeMME UBO, Brest, France*

From evolutionary and conservation perspectives, understanding what forces shape genetic diversity in natural populations is fundamental but it may be challenging for the marine megafauna. Sperm whale (*Physeter macrocephalus*), one of the most cultural species of the marine realm, presents a unique social organisation: adult male sperm whales are long distance runners, feeding in high latitudes and mating in warm waters where females and juveniles live in stable social groups assumed matrilineal. In Mauritius, a long-term monitoring based on underwater observations and a non-invasive individual-specific sampling of sperm whales enabled us to identify 25 adult females and juveniles belonging to a social unit and 26 adult males temporarily present in Mauritian waters. Through genetic analyzes (mitochondrial DNA control region sequencing and microsatellites profiling) on individuals from both this area and the Crozet/Kerguelen region, our study aimed to (1) investigate kinship and social dynamics of a social unit and, (2) study the phylogeography and geographical/social fidelities of adult males in the Indian Ocean. Based on our results, we can confirm the matrilineality of the social unit studied and show that kinship plays a strongly predominant but non-exclusive role in its dynamics. Moreover, we have identified several recaptures of adult males over years and deciphered some paternal kinships as well as captured a diagram of kin relationships on a large geographic scale. These findings
support a model of male-mediated gene-flow occurring at the level of the whole Indian Ocean, excluding social philopatry, but likely including a large-scale geographical fidelity for the ocean basin interconnected to a small-scale social fidelity for matrilineal social groups.

Stay behind, not high above – underwater noise levels of three drones measured at various horizontal and vertical distances

Maria Glarou¹, Amelie Laute², Flordespina Dodd³, Thomas Grove⁴, Synnøve Røsand⁴, Alyssa Stoller⁵, Marianne Helene Rasmussen⁶, Michelle E.H. Fournet⁷

¹University of Iceland, Husavik Research Centre, Húsavík, Iceland, ²Whale Wise, Kiel, Schleswig-Holstein, Germany, ³Whale Wise, Edinburgh, Select, United Kingdom, ⁴University of Edinburgh, Edinburgh, United Kingdom, ⁵Kristiansund, More og Romsdal, Norway, ⁶Whale Wise, Bellingham, Washington, ⁷Húsavík Research Center, University of Iceland, Húsavík, ⁸Sound Science Research Collective

Unmanned aerial vehicles (UAVs), or ‘drones’, serve as a powerful and cost-effective tool for cetacean research. Despite the increasing use of drones in ecological research, the impacts of drone noise on the marine environment remain largely unknown. In this study, we recorded underwater sound levels of three different UAV models (DJI Mavic Pro Platinum, DJI Phantom 4 Pro v2.0, DJI Inspire 1 Pro) commonly used in cetacean research. For each model, three replicate flights were conducted over 36 positions at standardized horizontal (0 – 30m) and vertical (2 – 40m) distances from the hydrophone (1m depth). Broadband received levels of the Inspire were highest with 91 dBRMS 250 – 17000 Hz re 1 μPa when flown at 0m distance and 2m altitude. Noise levels of the Phantom were lower (87.1 dBRMS 250 – 17000 Hz re 1 μPa) and the Mavic was quietest (80.7 dBRMS 250 – 17000 Hz re 1 μPa). Median ambient noise levels in the absence of a drone were 80.0 dBRMS 250 – 17000 Hz re μPa.

Standardizing horizontal distance at 0m, altitude was significantly associated with received levels up to 40m for both the Inspire and Phantom; the Mavic stopped significantly contributing to ambient sound after an altitude of 5m. In contrast, standardizing altitude at 2m, the Phantom and the Mavic significantly contributed to received levels to a horizontal distance of only 2m; the Inspire contributed to received levels up to 5m. In summary, drones contribute to ambient sound levels at higher altitude ranges than previously reported. Additionally, their contribution decreases more quickly with horizontal distance than with altitude. Despite the low broadband levels, the unnatural sound might cause disturbance to marine mammals. We recommend increasing horizontal distance rather than altitude to the animal to minimize noise impacts.

Photo-identification of pantropical spotted dolphins in Hawaiian waters reveals long-term re-sightings, supporting the existence of island-associated resident populations

Erin Gless¹, Sabre Mahaffy², Grace Olson³, Stephanie Stack¹, Jens Currie⁴, Robin Baird⁵

¹Cascadia Research Collective, Anacortes, WA, ²Cascadia Research Collective, Olympia, Washington, ³Pacific Whale Foundation, Wailuku, HI, ⁴Pacific Whale Foundation, ⁵Cascadia Research Collective, Olympia, WA

Pantropical spotted dolphins (Stenella attenuata) are abundant and distributed throughout tropical waters world-wide, yet studies based on individual photo-identification are limited. Three insular stocks (one each off O?ahu, Maui Nui, and Hawai?i Island) and one partially overlapping pelagic stock are recognized in Hawai?i, based on genetic analyses of biopsy samples and distributions of sightings along the island slopes. Fishery interactions regularly occur, particularly for the Hawai?i Island stock, but no bycatch or abundance estimates are available for any of the insular stocks. We used
Identifying Contaminants of Concern in Gray Whale using Skin Cell Cultures

Celine Godard-Codding1, Christiana Wittmaack2, Alexander Alexeev3, Jocylin Pierro4, James Surles4, Jeff Jacobsen5, Aimee Lang6

1Texas Tech University /The Institute of Environmental and Human Health, Lubbock, Texas, 2Texas Tech University, 3Indiana University, Indiana, 4Texas Tech University, Lubbock, TX, 5VE Enterprises, McKinleyville, California, 6NMFS, Southwest Fisheries Science Center, La Jolla, California

Gray whales (Eschrichtius robustus), migrate along densely populated coastline increasing exposure risk to anthropogenic contaminants. We investigated the cytotoxicity of several organic pollutants. Polycyclic aromatic hydrocarbons (PAHs) are produced during incomplete combustion processes of petroleum and wood. Per- and polyfluoroalkyl substances (PFAS) are used as stain and water repellants. Polychlorinated biphenyls (PCBs) were primarily used for insulation. Crude oil enters the marine environment via seeps and spills. Corexit™ is a commonly used oil dispersant. PAHs, PCBs, and PFAS have been reported in the blubber of cetaceans. Cell culture is an ideal tool as investigations are minimally invasive. Cultures can be propagated from small biopsies and multiple investigations can also be conducted using tissue from a single biopsy. Our overarching goal is to understand whether these contaminants are cytotoxic to gray whale skin fibroblasts. We also aim to pinpoint the contaminants of most concern for the gray whale. To accomplish this, we collected skin biopsies from three free ranging gray whales off the coast of California and cultured skin fibroblasts from the epidermis. Cells were maintained in DMEM/F12 media supplemented with cosmic calf serum, penicillin streptomycin, glutamax™, and sodium pyruvate. Cells were dosed with B[a]P, PCB126 (0.01 µM, 0.10 µM, 1.00 µM and 10.00 µM), PFOA (0.05 µM, 0.50 µM, 5.00 µM, 50.00 µM, and 500 µM), or media accommodated fractions of crude oil and/or Corexit™9500A for 24h, 48h, 72h, or 96h exposure periods. Cytotoxicity was determined via both MTT (methylthiazolyldiphenyl-tetrazolium bromide) and LDH (lactate dehydrogenase) assays. Results from the MTT indicate that viability was significantly reduced after exposure to all toxicants at various time points (p<0.05). We found that the LDH was less sensitive in detecting cytotoxicity when compared to the MTT. Finally, LC50 (the concentration at which 50% mortality is observed) values were calculated from the MTT data. LC50 values...
Stable isotopic analysis indicates St. Lawrence and eastern Chukchi Sea Pacific walrus (Odobenus rosmarus divergens) occupy a distinct isotopic niche compared to southeastern Bering Sea walrus

Genevieve Godfrey¹, Kerri J. Smith¹, Lori Quakenbush², Lara Horstmann³, Stephen Trumble⁴

¹Baylor University, ²Alaska Dept. Fish and Game, Fairbanks, Alaska, ³University of Alaska Fairbanks, College of Fisheries and Ocean Sciences, Fairbanks, Alaska, ⁴Baylor University, Waco, Texas

Colonization and early population growth of Northern Elephant Seals (Mirounga angustirostris) at the King Range National Conservation Area in Northern California

Dawn Goley¹, Emma Levy²

¹Cal Poly Humboldt, Arcata, California, ²Humboldt State University, Arcata, CA

The northern elephant seal (Mirounga angustirostris) population has recovered from less than 100 in 1900 to over 200,000 individuals. The King Range National Conservation Area colony was established in 2015 by a few seals in the northernmost portion of their breeding range. We monitored this fledgling colony from late 2017 to document its expansion and changing demography with regular surveys and by resighting unique identifiers from flipper tags. As expected, seal counts were highest during the winter breeding season, the spring adult female/juvenile molt, and the fall juvenile haul-out. We observed a modest increase in pup production (< 13%) from 2017 to 2020 and a marked (65%) increase from the 2020 to the 2021 breeding season (185 total pups). Initial colony growth was driven by immigration. We resighted 343 tagged individuals from King Range and six other colonies, with most coming from the nearest colony at Point Reyes (30%) and the fewest coming from the most distant colony on San Miguel Island (0.2%). Of these tagged seals, 3% were first sighted as young...
adult males, 9% as adult females, and 86% as juveniles. Among the juveniles resighted, only 26% were born at King Range. Based on pup production, we estimate the current colony population to be 814 individuals. The King Range site offers a vast, undisturbed, and relatively cool shoreline habitat for elephant seals. Patterns of explosive growth documented at older colonies suggest the King Range colony size will likely double in the next five years and may exceed 10,000 individuals within 20 years. As the most northern established breeding site, the King Range may become an important ‘seed’ colony as the elephant seal population continues to increase and expand northward, presenting challenges for coastal land managers and opportunities for research into the recovery of this iconic species.

**Using Stable Carbon and Nitrogen Isotope Ratios to explore turnover rate in skin of Western Arctic Bowhead Whales**

Orlin Gologergen¹, Andrew Cyr², Lauren Wild¹, Jan Straley³, Lori Quakenbush⁵

¹University of Alaska Fairbanks, Fairbanks, AK, ²State of Alaska, Anchorage, Alaska, ³University of Alaska Southeast, Sitka, Alaska, ⁴University of Alaska, Sitka, Alaska, United States Minor Outlying Islands, ⁵Alaska Dept. Fish and Game, Fairbanks, Alaska

Bowhead whales are an important traditional food source for Alaska Native people who live along the coasts of the Bering, Chukchi, and Beaufort seas. Stable isotope analysis has been done across the length of plates of bowhead whale baleen and shown changes in ratios that reflect migratory routes. Samples are available from the subsistence harvest for isotopic studies. A pilot study using a piece of bowhead whale skin (3 by 3 by cm) donated from a subsistence user was cut into six cores and each core was cut into 1/2 cm pieces (i.e., layers) with each layer representing a greater distance from the surface of the skin to a maximum depth of 3 cm. Skin samples will be cut as described above and dried, ground into a fine powder, lipid extracted, and processed at the Alaska Stable Isotope Facility in Fairbanks, Alaska. Each layer was analyzed for carbon and nitrogen isotopes. The isotope ratios of each layer clustered together and appeared visually distinct. Carbon isotope ratios decreased and increased moving from the outer layer towards the inner layer, which indicates a cyclical pattern. Nitrogen isotope ratios decreased slightly moving from the outer layer towards the inner layer. Results provided evidence that a dietary time series may exist with depth in layers of skin. We aim to expand the pilot study by analyzing isotope ratios in additional pieces of bowhead whale skin obtained from the subsistence harvest to verify that the layer-based variability we observed is consistently present. We will use these results to estimate turnover rates in bowhead whale skin from a comparison with the baleen timelines and known migratory pathways. Turnover rate estimates for bowhead whales may serve as a reference point for other large whales for which no estimates exist and samples are difficult to obtain.

**New evidence for important Mediterranean monk seal habitat**

Joan Gonzalvo¹, André Guinand², Julien Pfyffer²

¹Tethys Research Institute, Milano, Milano, Italy, ²Octopus Foundation, Switzerland

Historically, Mediterranean monk seals *Monachus monachus* commonly used to haul out on open beaches. However, in more recent times, probably as an adaptation to increased human disturbance, they generally seek refuge in marine caves characterized by entrances above or below water level, a corridor, an internal pool, and a beach that provides a dry haul-out area. Resting does not occur exclusively in these caves; Mediterranean monk seals have been reported sleeping, either at the surface floating, or underwater on the seafloor or over
seagrass beds with eyes and nostrils shut. In July 2020, while testing an autonomous monitoring system in a cave of the Ionian Sea, an additional underwater camera was deployed in an adjacent rocky cavity. This cave was almost completely flooded, had a small air chamber above, presented no surface or structure to haul-out and communicated on one side with a larger cave and, on the opposite side, with the open sea. During 15 days of continuous monitoring (photos triggered every 5 min) seal presence was unambiguously established in 12 days and recorded during consecutive periods of up to 3 hours during which the seal/s were mostly lethargic, floating at the surface or sleeping underwater with their eyes shut. Up to three seals were simultaneously observed. Seal detection was limited by light conditions and observations were recorded during daylight hours; nevertheless, the presence of seals at night cannot be ruled out. Our observations present evidence that caves traditionally considered “sub-standard” caves may have been neglected when producing habitat assessments for Mediterranean monk seals, and should be included in future habitat evaluation since they also provide important shelter and resting opportunities for this endangered species.

Relative contributions of humpback whale and vessel presence to ambient sound levels in Cod Grounds Marine Park, Australia

Rochelle Gordon¹, Jessica McCordic², Annamaria DeAngelis³, Timothy J. Rowell⁴, Jeremy Smith⁵, Candace McBride⁶, Giverny Rodgers⁷, Sofie Van Parijs⁸

¹NOAA / NMFS / NEFSC / Integrated Statistics, New Bedford, Massachusetts,
²NOAA/NMFS/NEFSC/Integrated Statistics, Woods Hole, MA, ³NMFS/NEFSC, Woods Hole, MA, ⁴Parks Australia, Canberra, ACT, Australia, ⁵NOAA NMFS NEFSC, Woods Hole, MA

Australian Marine Parks (AMP) represent a vast network of marine protected areas managed to protect biodiversity of the marine environment. Within some parks, certain areas are further designated as National Park Zones (NPZs) which prohibit extractive activities including recreational and commercial fishing. NPZs still allow transit through the zone, so even vessels compliant with regulations will introduce anthropogenic noise, potentially impacting the overall soundscape of the NPZ. Cod Grounds Marine Park (CGMP), located on the east coast of Australia, represents a biologically important habitat for marine species. Zoned as a National Park, CGMP spans 4 km², reaching depths of 46 m. We deployed acoustic recorders in CGMP over two deployments. The first deployment took place in the summer season, from 12/12/2018 – 2/20/2019. The second deployment took place in the following winter season from 4/11/2019 – 6/24/2019. All acoustic data were manually reviewed for hourly presence of biological sounds and vessel passages. Previous work using these recordings found that biological sources are the primary drivers of soundscape characteristics at a seasonal scale. Humpback whales (Megaptera novaeangliae) were identified as a significant contributor to the overall soundscape of CGMP due to their singing activity during the winter migration period. Ambient sound levels were measured during periods of vessel passages and humpback whale songs to assess relative contributions of each source at a finer temporal scale. These measurements allow managers to establish baseline metrics of potential short-term impact of anthropogenic sound sources within the NPZ. Integrating these findings with previous work at the deployment scale will allow for more effective monitoring of changes in the soundscape of the NPZ over time.
Improving Matching and Documenting Error Rates in Photo-id Studies
Antoinette Gorgone¹, Aleta A. Hohn², Barbie Byrd³
¹University of Miami-CIMAS, NOAA Fisheries Southeast Fisheries Science Center Beaufort, USA, Beaufort, North Carolina,
²NOAA/NMFS/SEFSC, Beaufort, North Carolina,
³NC Division of Marine Fisheries, Morehead City, North Carolina

Photo-identification in marine mammal studies provides valuable insight into animal movements, survivorship, and population estimates. This process requires a photo of an individual animal to be visually matched by an experienced researcher to a catalog comprising other distinct individuals. Human errors occur during this process but the rate, if known, is not usually mentioned in published studies. In this study, finFindR was used to detect errors in three existing catalogs of common bottlenose dolphins (Tursiops truncatus) that were originally created using standard photo-identification techniques with primary and secondary reviewers to verify matches, missed matches, and false positives/negatives (FP/FN). The machine-learning matching assistance software finFindR, has been shown to considerably reduce the time to conduct photo analysis, with reported error rates between < 3 - 13%, for the 50 top-ranked candidate matches. We reviewed the top 50 matches identified by finFindR and found 98 errors (FP=3, FN=95) in the long-term (23 years) catalog (2738 individuals, 5620 photos). As expected, we found fewer errors in the two short-term (3 weeks) catalogs (Catalog A: 560 individuals, 1034 photos; Catalog B: 634 individuals, 757 photos). Specifically, Catalog A had one 1 FP, and Catalog B had 3 FN. Even though calculated error rates were small with our standard human-matching practices, finFindR found more matches, further reducing the error rate. In addition, matches were found before having to review all 50 candidates proposed by finFindR, further reducing the time to match, relative to using standard photo-identification techniques. Errors may never be eliminated with finFindR or similar machine-learning programs, but these programs produce more accurate results with reported error rates that should be published for photo identification catalogs supporting population studies. Furthermore, finFindR saves time and financial resources, overcoming the requirement to match all possible dolphins using standard methods.

Investigation of fine-scale population structure and genetic diversity of the Atlantic white-sided dolphin (Lagenorhynchus acutus) across the eastern North Atlantic
Marc-Alexander Gose¹, Emily Humble², Mariel ten Doeschate¹, Nick Davison¹, Andrew Brownlow⁵, Rob Ogden⁶
¹University of Edinburgh, Bochum, Nordrhein-Westfalen, Germany, ²University of Edinburgh, United Kingdom, ³Scottish Marine Animal Stranding Scheme, Inverness, Highlands, United Kingdom, ⁴Scottish Marine Animal Stranding Scheme, Inverness, United Kingdom, ⁵SRUC, Inverness, United Kingdom, ⁶University of Edinburgh, Edinburgh, Midlothian, United Kingdom

Oceanic dolphins such as the Atlantic white-sided dolphin (Lagenorhynchus acutus) are challenging species to monitor and there is therefore a relative paucity of data in terms of their ecology, life history, and population structure. This can hamper accurate assessment of their conservation status. Given the logistical and financial difficulties of obtaining data from free-ranging oceanic dolphins, investigations of stranded animals provide an important source of information regarding pathology (disease status through microbiological analyses), ecology (e.g., assessment of stomach contents) or life history parameters and an exceptional opportunity for obtaining tissue samples from individuals throughout large parts of their geographic range. Here, we investigated 92 tissue samples of
Atlantic white-sided dolphins collected between 1992 and 2020 on coastlines of the eastern North Atlantic. We sequenced the mitochondrial control region and used a restriction-site associated DNA marker approach (DArTseq™) to generate a total of 41,000 nuclear markers, which were used to assess genome wide heterozygosity and perform multivariate and Bayesian analyses to estimate population structure. Results imply a widely connected population of Atlantic white-sided dolphins without any clear signs of reduced gene flow across the eastern North Atlantic. Adopting a multidisciplinary approach and combining more in-depth sequencing data with additional data on abundance and life history will provide valuable insights to assist in the conservation management of this data deficient species.

**Cetacean Restoration in the Wake of Deepwater Horizon: More than the sum of individual parts**
LAURA ENGLEBY1, Elizabeth Fetherston-Resch2, Rebecca Hazelkorn3, Stacey Horstman4, Erin Fougeres4, Julia Goss5, Teresa Rowles6
1NOAA NMFS Southeast Region, 2NOAA, SAINT PETERSBURG, FL, 3NOAA, National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, Florida, 4NOAA Fisheries Southeast Regional Office, St. Petersburg, FL, 5NOAA, Washington, DC, 6Silver Spring, Maryland

The diverse number and geographic range of cetaceans (at least 15 species/22 stocks) affected by the BP Deepwater Horizon (DWH) oil spill is unprecedented. These animals face numerous natural and human-caused threats and other stressors in the Gulf of Mexico, and DWH restoration represents a unique opportunity and novel mechanism to better understand and address them while restoring for injury. Despite tremendous progress towards understanding oil impacts on marine mammals and recovery timelines since Exxon Valdez, this is the first attempt at restoration of cetaceans on such a large scale.

This presentation will address how restoration planning and implementation are creating new frameworks for how we think about and implement actions that support marine mammal population recovery to levels they would have been but for the spill. This includes identifying how to enhance and sustain long-term data collection for informing restoration, monitoring, adaptive management, and evaluating success. Formation of sustainable partnerships among states, federal agencies, academics, industries, NGOs, and others that will outlive and outperform the restoration time frame are critical for success. Challenges associated with restoring marine mammals - using only voluntary frameworks, operating among multiple mandates (OPA, MMPA, ESA, etc.), absence of a pre-restoration baseline - will also be discussed. Overall this is a unique opportunity that demands a novel and integrated restoration strategy to examine the long term aftermath of a large spill on biological and physical resources in the Gulf and the impact that restoration may have on cetaceans and the health of the Gulf of Mexico as a whole. This process has implications that reach beyond the region, as the lessons learned from DWH can be exported to inform threat and stressor evaluation, restoration planning, monitoring, and effective adaptive management, all to the benefit of conservation.

**Prey of Steller sea lions hauled out on the Benten-Jima Rock, near Cape Soya Hokkaido, Japan**
Yoko Goto1, Koichiro Nakano2, Tadao Bando1
1Hokkaido Research Organization, Wakkanai-city, Hokkaido, Japan, 2Bioengineering Lab. Co., Ltd., Sagamihara-city, Japan, 3Soya Fisheries Cooperative, Wakkanai-city, Hokkaido, Japan

Since 2016, large numbers of Steller sea lion (Eumetopias jubatus) have gathered around Cape
Soya, Hokkaido, Japan in the spring. In the past, the number of haulouts on the Benten-Jima Rock near Cape Soya was at most a few hundred; however in May 2017, more than 6,000 individuals (sum of the haulout and raft) were counted. The cause of this large gathering of sea lions remains unclear. To understand the cause of this phenomenon, we conducted a diet analysis of Steller sea lions based on feces. To clarify the prey of sea lions, we performed DNA analysis of 24 feces samples collected at the Benten-Jima Rock in June 2016. We used previously reported fish-specific (MiFish; Miya et al. 2015) and cephalopod-specific (Jarman et al. 2006) universal primers to amplify DNA and analyzed the results using the MiSeq next-generation sequencer (Illumina). Polymerase chain reaction-amplified partial mitochondrial DNA (fish) and rDNA (cephalopod) gene sequences from feces DNA were detected in the database and the prey species fed on by Steller sea lion were subsequently identified. The major identified prey species was sandlance (*Ammodytes* spp., occurrence frequency: 100%). According to information from other fishery surveys, sandlance bycatch, which had not been previously recorded, increased rapidly after 2016. These results suggest a possible relationship between the large aggregation of sea lions and the prey environment.

**Scaling of Lunge Feeding Kinematics in Baleen Whales**

William Gough¹, David Cade², Jean Potvin³, Shirel Kahane-Rapport⁴, Jeremy Goldbogen⁵

¹Stanford University, Pebble Beach, CA, ²Stanford University, ³St. Louis, MO, ⁴Hopkins Marine Station, Stanford University, Pacific Grove, CA, ⁵Stanford University, Pacific Grove, CA

Although gigantic body size and obligate filter feeding mechanisms have evolved in multiple vertebrate lineages (mammals and fishes), intermittent ram (lunge) filter feeding is unique to a specific family of baleen whales: rorquals. Lunge feeding is a high cost, high benefit feeding mechanism that requires the integration of unsteady locomotion (i.e. acceleration and maneuvers) and the impact of scale on the biomechanics and energetics of this foraging mode continues to be the subject of intense study. The goal of our investigation was to use a combination of multi-sensor tags paired with drone footage to determine the impact of morphometrics such as body size on kinematic lunging parameters such as fluking timing, maximum lunging speed, and deceleration during the engulfment period for a range of species from minke to blue whales. Our preliminary results show that, in the case of krill-feeding lunges and regardless of size, animals time the cessation of fluking to coincide with both the maximum lunging speed and the point of mouth opening. Given the ability of rorquals to engulf large volumes of water using their momentum, we predicted the optimal speed of lunging across scale. In order to minimize the energetic cost of lunge feeding, hydrodynamic theory predicts slower lunge feeding speeds regardless of body size, with a lower boundary set by the ability of the prey to avoid capture. We used empirical data to test this theory and instead found that maximum feeding speeds remain constant and high (~4 m s⁻¹) across body size. Using these preliminary kinematic measurements, we estimated the ratio of energetic cost to energetic gain from prey across a wider body size range than previous studies and confirmed an increasing relationship with body size, suggesting that larger whales are capturing more prey – and more energy – at a lower cost.

**Interspecific and Intergenerational Differences in the Molar Occlusal Surfaces of Manatees (Trichechidae)**

Lyle Goulbourne¹, Daniel Gonzalez-Socoloske², Daryl Domning³

¹Andrews University, Yucaipa, CA, ²Department of Biology, Andrews University, Berrien Springs,
One of the most unique features of manatees (Trichechus spp.) are their teeth, which are perfectly made to combat their abrasive diet by continuously being replaced along a horizontal axis, with new teeth added at the posterior end and older teeth falling out at the anterior end throughout their lifetime. While much is known regarding limitless horizontal replacement of manatee teeth, the morphology, topography, and enamel structure of the teeth have not been formally described, nor have interspecific differences in relative tooth size been described in detail. To physically describe the teeth, photographs of the molars from Florida manatees (T. manatus latirostris) and Amazonian manatees (T. inunguis) were taken and analyzed. Analysis included formal description and identification of the cusps and lophs/ridges of the molars. To address relative tooth size differences, the area of the posterior-most molar in occlusion was measured from both the upper and lower molars of the manatee skulls from each taxon in our collection. Florida manatees had significantly larger teeth than Amazonian both absolutely (t(87) = 10.2, p < 0.05) and relatively (t(87) = 8.8, p < 0.05). The relative comparison was achieved by comparing ratios of condylobasal length over tooth area.

Friends through the ages: bottlenose dolphin calves maintain associations as juveniles
Michelle Greenfield1, Wendy Noke-Durden2, Agatha Fabry3, Teresa Jablonski1, Lydia Moreland4, Lisa Gemma1, Heidy Clifford5
1Cornell University College of Veterinary Medicine, 2Hubbs-Sea World Research Institute, Melbourne Beach, FL, 3Hubbs-SeaWorld Research Institute, 4Harbor Branch Oceanographic Institute, 5SeaWorld

Associations between common bottlenose dolphins (Tursiops truncatus) influence sociality, behavioral traits, survival, and longevity. Of particular importance in the early stages of development are the associations between mothers and dependent calves. While behavioral characteristics associated with the transition from a dependent calving state to an independent juvenile state have been documented, there are limited studies that examine the associations between these two time periods. This study aims to document association longevity for bottlenose dolphins as they transition from dependent calves to independent juveniles and determine the extent to which kinship plays a role in the development of these associations. Using social network analysis, a generalized linear mixed model (GLMM), and a tiered association scale, we found 53.7% of total associations from the dependent calving state were retained to the independent juvenile state. Of preferred associations (associations with HWI > twice the mean population non-zero HWI, 0.178) in the independent state, 80% were with associates from infancy to weaning. Additionally, preferred associates in the independent state that were maintained from infancy had 3.6 times greater odds of associating and 5.67 times greater odds of being a preferred associate in the independent state (P < 0.0001). The majority of independent juveniles, 84.62%, maintained a moderate level association (HWI = 0.179-0.54) with their mother, and a few retained their mother as their top associate. Kin were found to be the top independent juvenile associate in 26.92% of cases. Examining the ontogeny of association patterns within Tursiops population dynamics is a critical component to understanding calf development and survival. Recognizing continuity in associations amongst individuals, particularly those in understudied and highly vulnerable areas, provides essential information to further the understanding of life-history patterns, cultural transmission of high-risk behaviors, as well as disease transmission amongst the population, and can inform management and conservation efforts.
Building a US West Coast-Wide Entanglement Response Database (ERD)
Justin Greenman¹, Jeff Adams², Sarah Wilkin³, Stephen Manley⁴, Justin Viezbicke⁵, Lauren Saez⁶, Lauren De Maio⁷, Dan Lawson⁷
¹NOAA Fisheries, Long Beach, CA, ²NOAA Fisheries, Silver Spring, Maryland, ³National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD, ⁴NOAA/NMFS/OPR, ⁵NMFS, Portland, OR, ⁶Ocean Associates, Inc. for West Coast Region, National Marine Fisheries Service, NOAA, Long Beach, ⁷West Coast Region, National Marine Fisheries Service, NOAA, Seattle, WA

From 1982-2020, over 650 large whale entanglements were reported to the NOAA Fisheries’ West Coast Region Large Whale Entanglement Network (Network), which covers the coasts of California, Oregon, and Washington. Each of these entanglement cases includes reporting data, entanglement gear/material information and in some cases gear set notes and photos/videos of the whale and gear. In over 250 of these cases, a Network response was initiated, bringing with it a completely new set of response data. To manage the different data streams associated with entanglements, NOAA Fisheries’ West Coast Regional Office (WCRO) and Office of Protected Resources’ Marine Mammal Health and Stranding Response Program (MMHSRP) have developed an Entanglement Response Database (ERD). The original ERD was stored in a customized Microsoft Access database system designed for dolphin dorsal fin matching (FinBase). This structure provided a great start for our data management, but it was found to be limiting. To manage the complete set of data parameters associated with entanglements, we adopted a flexible data model designed to accommodate the storage, management and analysis of any kind of event based data. Including stranding response, photo-identification research, and health assessments for multiple species and regions. The new ERD allows users to enter and store multiple reports, gear types and responses under the same case record. The restructure also gives users a more refined way to store Network response data. This allows users to track the success rate of using specific disentanglement tools on different gear/entanglement types as well as track the activity and progress of individual responders and teams. The ERD also now incorporates forensic data from post-response gear assessments and animal resight data from research and citizen science partners. The ultimate goal for this effort is to create a data standard that can be adopted by other regions.

Detection and Investigation of estuarine and coastal bottlenose dolphins (Tursiops truncatus) using environmental DNA
Kathryn Greiner-Ferris¹, Erin Burge², Patricia Rosel³, Robert Young⁴
¹Coastal Carolina University, University of Central Florida, Orlando, Florida, ²Coastal Carolina University, ³NOAA Fisheries, Lafayette, Louisiana, ⁴Coastal Carolina University, Conway, South Carolina

Environmental DNA (eDNA) analysis is a non-invasive monitoring technique that can detect and potentially monitor elusive marine mammals. To date, the majority of eDNA studies have been performed in freshwater environments, partially due to methodological challenges posed by higher salinities and increased dilution effects of large water masses in marine environments. The objective of this study was to design and optimize oligonucleotide PCR primers to accurately detect and quantify common bottlenose dolphin (Tursiops truncatus) eDNA and to evaluate potential trends between eDNA concentration and dolphin abundance. Environmental DNA collection surveys were carried out from March 2019 to November 2019 in two estuarine salt marshes (North Inlet and Cape Romain) and the coastal ocean in South
Carolina, USA. A total of 176 water samples were analyzed, including 132 from predetermined survey locations and 44 collected directly in the wake of dolphins. Primer pairs were designed to target a 92 base pair (bp) fragment of the mitochondrial DNA (mtDNA) Cytochrome b gene (cytb). We found evidence for dolphin presence through eDNA in all three sites even when dolphins were not observed. A positive relationship was observed (1) between dolphin sightings/survey and mean eDNA concentration/survey and (2) between dolphin group size and eDNA concentration of water samples collected in the group’s wake. Our findings provide evidence for the utility of eDNA techniques in examining the presence, relative abundance, and distribution of common bottlenose dolphins.

A Systematic Study of Depredation by Common Bottlenose Dolphins (Tursiops truncatus) on Reef Fish Captured and Released by Rod and Reel Fisheries in the Northeastern Gulf of Mexico

Corie Grewal¹, Jessica Powell², Oscar Ayala¹, Stacey Horstman³, Andy Read⁴

¹Duke University, ²NOAA Fisheries Service, Southeast Regional Office, St. Petersburg, Florida, ³Florida Fish and Wildlife Conservation Commission, ⁴NOAA Fisheries Southeast Regional Office, St. Petersburg, FL, ⁵Duke University, Beaufort, North Carolina

In the northeastern Gulf of Mexico, depredation by common bottlenose dolphins Tursiops truncatus on rod and reel fishing gear leads to increased costs for anglers and serious injury and mortality for dolphins. We analyzed a dataset that included a type of depredation known as scavenging, where dolphins eat fish that thrown back after being caught, which was collected by the Florida Fish and Wildlife Conservation Commission fisheries dependent monitoring at sea observer program. Our aim was to determine contributing factors to, spatial distribution of, and frequency of interactions for bottlenose dolphin scavenging from 2009–2020. The dataset included 110,575 observations of fish that were caught onboard fishing charter and head boats, of which 269 were recorded as dolphin scavenging events after the fish was thrown back. We chose potential predictive factors from the dataset based on their known or hypothesized influence on dolphin behavior and used a generalized linear model (GLM) to examine relationships between instances of scavenging and these predictive factors. This study is the first systematic bottlenose dolphin scavenging study that incorporates fisheries observer data. Key findings can help inform management and mitigation of bottlenose dolphin scavenging in the Gulf of Mexico and provide a baseline for future scientific study.

Optimal Sea Otter Weaning and Pup Abandonment

Blaine Griffen¹, Nicole Thometz², Lexanne Klimes³, Laura Fletcher³

¹Brigham Young University, ²University of San Francisco, San Francisco, CA, ³Brigham Young University - Provo, UT, Provo, Utah

Female sea otters experience extreme energetic constraints throughout their adult lives as they continually care for pups. Recent work highlights evolutionary tradeoffs that likely occur as individual females balance current and future reproductive success. These tradeoffs should manifest in differential weaning ages for pups depending on the age and body condition of the mother, and on the foraging quality of the habitat, which is often largely determined by otter density. We used existing data to develop a dynamic state variable model that we used to determine optimal weaning times for female sea otters with pups. Our model predicted that mothers in their first or second reproductive attempt (ages 3 and 4) should abandon pups at the earliest possible point when pups could survive on their own (~day 120 of pup care),
while older females should care for pups for progressively longer time periods; however the evolutionary pressure driving these age-specific differences is weak. We also found that the duration of pup care should increase with maternal body condition, and that the evolutionary pressure driving these differences should weaken with age. Finally, females in resource-abundant habitats should care for pups longer than females in resource-poor habitats, though this difference was only minor. These model predictions broadly agree with empirical data for sea otters across their current range in California, suggesting that our model accurately captures sea otter physiology. We then used Monte Carlo simulations of the model to predict sea otter reproductive performance and population growth potential under a range of conditions such as further Pacific warming, changes to food availability, and other factors that could potentially influence maternal condition. Together these models can help improve understanding of optimal sea otter behavior as well as identify factors that may influence the recovery of this threatened keystone species.

Quantifying mercury in the common bottlenose dolphin (Tursiops truncatus) in the Southeast, USA

Mackenzie Griffin1, Colleen Bryan2, Brian Balmer3, Russell Day4, Antoinette Gorgone4, Jenny Litz5, Teresa Rowles6, Lorelei Schwacke7, Randall Wells8, Eric Zolman9, Tara Cox10

1Savannah State University, 2National Institute of Standards and Technology, Charleston, South Carolina, 3National Marine Mammal Foundation, Johns Island, SC, 4National Institute of Standards and Technology and Marine Science and Nautical Training Academy, Charleston, South Carolina, 5University of Miami-CIMAS, NOAA Fisheries Southeast Fisheries Science Center Beaufort, USA, Beaufort, North Carolina, 6Marine Mammal and Turtle Division, SEFSC, NOAA Fisheries, Miami, Florida, 7Silver Spring, Maryland, 8National Marine Mammal Foundation, 9Chicago Zoological Society’s Sarasota Dolphin Research Program, Sarasota, Florida, 10National Marine Mammal Foundation, San Diego, California, 11Savannah State University, Savannah, Georgia

The common bottlenose dolphin (Tursiops truncatus) is a sentinel species for human and ecosystem-level health due to having a long lifespan and some populations having site fidelity to localized bays, sounds, and estuaries (BSEs). Bottlenose dolphins are top-level predators that biomagnify and bioaccumulate mercury. Exposure to mercury can cause neurotoxicity in humans, and elevated mercury concentrations have been associated with changes in blood chemistry and endocrine markers in dolphins. The objective of this study was to measure mercury in bottlenose dolphin skin and examine spatial patterns among BSE populations across the U.S. Southeast Atlantic and Gulf of Mexico coasts. We collated unpublished and published mercury data previously measured from dolphin health assessments and remote biopsy sampling in BSE waters near: Charleston, South Carolina (2003-2005; n = 74), Sapelo Island, Georgia (2007-2009; n = 37), Brunswick, Georgia (2006-2007 and 2009; n = 40), Indian River Lagoon, Florida (2003-2005; n = 75), Biscayne Bay (2019; n = 18), Lower Florida Keys (2008; n = 10), Florida Coastal Everglades (2013; n = 24), Sarasota Bay, Florida (2002-2004; n = 55), St. Joseph Bay, Florida (2005-2006; n = 24), and Choctawhatchee, Florida (2007; n = 12). We conducted additional remote biopsy sampling from dolphins near Savannah, Georgia (2015 and 2017; n = 45) and measured mercury in skin. Mean mercury mass fractions were greatest in St. Joseph Bay samples (14.2 mg/g) and lowest in Charleston samples (0.51 mg/g). The greatest mercury exposure in St. Joseph Bay dolphins is likely related to the great rate of atmospheric mercury deposition in the northern Gulf of Mexico, which is known to be one of the greatest in North America. Spatial comparisons of
mercury mass fractions in bottlenose dolphins is important for developing a better understanding of mercury exposure in top-level marine predators and identifying potential hot spots for mercury contamination.

**Exploration of Novel PFAS Extraction Techniques from Dried Blood Spots for Prospective Marine Mammal Health Assessments**

Emily Griffin¹, Juan Aristizabal-Henao², John Bowden²

¹University of Florida, Gainesville, Florida, ²The University of Florida, Gainesville, FL

Whole blood is widely used in clinical research to measure biological markers and their associations with diet, stressors, and pathophysiological states. The advent of minimally invasive sampling strategies has further propelled the possibilities for human health assessment. Specifically, the use of dried blood spots (DBS) has increased in recent years in research and clinical settings, as this sampling technique offers several advantages over conventional blood collection methods including facilitated sample handling, shipping, and storage, while providing increased analyte stability as stored materials. DBS offer the potential to reduce human interaction and amount of biological material that must be collected during routine health assessments of endangered or threatened species. Marine mammals such as the West Indian manatee, can serve as informative environmental sentinels both for the presence and effect of anthropogenic chemicals such as per- and polyfluoroalkyl substances (PFAS), as well as other environmental stressors in highly variable and shared environments to humans (e.g., coastal waters). PFAS are a group of anthropogenic chemicals that have been increasingly identified in terrestrial and aquatic ecosystems. In this study, we examined five extraction techniques employing different volumes, ratios, and types of solvents to determine the optimal analytical method for PFAS profiling in DBS from Florida manatees. Targeted mass spectrometric workflows, employing ultra-high performance liquid chromatography coupled to tandem mass spectrometry, were utilized. Determining to what extent a wildlife population is affected by environmental stressors (e.g., contaminants, algal blooms, climate change) is a central theme of ecotoxicology and wildlife pathology and overall, an important bridge to understanding common overlaps with human health. We aim to utilize the DBS extraction technique developed in this study to supplement routinely collected data in order to provide further insights regarding manatee health.

**The Impact of a Change in Shipping Lane Location on the Acoustic Presence of Harbour Porpoises**

Julia Carlström¹, Mathias Andersson¹, Emily T. Griffiths³, Emilia Lalande¹, Kylie Owen⁴, Signe Sveegaard⁵, Jakob Tougaard⁶, Pia Eriksson⁷, Robin Nordström⁸, Mel Cosentino⁹, Line Kyhn¹¹

¹Swedish Museum of Natural History, Stockholm, Stockholm, Sweden, ²Stockholm, Stockholm, Sweden, ³Aarhus University, Denmark, ⁴FOI, Swedish Defence Research Agency, Department of Underwater Research, Stockholm, Stockholm, Sweden, ⁵Swedish Museum of Natural History, Örebro, Sweden, ⁶Aarhus University, Roskilde, Denmark, ⁷Aarhus University, Roskilde, ⁸Department of Environmental Research and Monitoring, Swedish Museum of Natural History, Stockholm, Sweden, ⁹Department of Underwater Research, Swedish Defence Research Agency (FOI), Stockholm, Sweden, ¹⁰Whalesafari Andenes, Aarhus, Denmark, ¹¹Institute of Bioscience, Aarhus University, Roskilde, Denmark

Underwater noise from shipping is the dominate source of low frequency anthropogenic noise in the world’s oceans, and is a well-recognised threat to cetaceans. Cetaceans have been shown
to react to ship noise at fine spatial and temporal scales (kilometers and minutes), with possible impacts including disturbance of behaviour and masking of communication. However, when considering impacts on habitat quality and area use over time, it is often difficult to separate the impact of ship noise from other factors such as poorer habitat quality and prey availability, as the noise generated from ships in shipping lanes cannot be removed or controlled. This means that there is still a lack of understanding of exactly how shipping noise influences cetacean behaviour and distribution over longer time (months-years) and spatial (10s kilometres) scales. During 2020, a major shipping lane in the waters between Sweden and Denmark (the Kattegat Sea) was partly re-routed in order to increase shipping safety. The aim of this study was to investigate the impact that this change in shipping lane location had on harbour porpoise behaviour and distribution. Concurrent data on noise (48 kHz minimum sample rate), ship traffic (AIS), and porpoise acoustic presence (CPODs) were collected for one year prior to and one year after the shipping lane change (1 July 2020). A mixed modelling framework was used to investigate the impact of both vessel presence and anthropogenic noise level on the detection rate of harbour porpoises. This study is the first to examine what happens to a cetacean population over time if a shipping lane is removed from one area, and added to another. Given the predicted increase in shipping noise in the world’s oceans in future, this improved understanding on how shipping noise influences the large-scale occurrence of a species is essential to effective future management.

Identification of patterns in trait evolution is essential to understanding the interaction of evolutionary forces, and provides useful information for species management. Such traits are not limited to physical dimensions, as increasing awareness of animal culture promotes inclusion of behavioural adaptation in evolutionary research. Cetaceans are a well-defined infraorder of mammals that exhibit distinct trait variation across behavioural, molecular and life history dimensions, yet few researchers have applied a meta-analytic or comparative approach to these traits. To understand cetacean trait evolution, we used a phylogenetic generalised least squares approach to examine the cognitive buffer hypothesis, which expects an extended lifespan would be selected for when reproductive onset is delayed due to lengthy neural and behavioural development. We found a negative correlation between brain size and lifespan, suggesting that cetacean brain size and lifespan experience selective pressures different from most other mammals, but similar to some social mammalian carnivores which also display alloparenting. This work provides a comprehensive dataset to explore additional aspects of trait evolution but would greatly benefit from studies on behavioural ecology across cetaceans and increased focus on data deficient species.

Unravelling Isoscapes at the Base of the Antarctic Ecosystem for Robust Dietary Evaluation of Humpback Whales

Jasmin Gross1, Rita M. Franco-Santos2, Patti Virtue2, John Totterdell1, Claire Garrigue1, Milton Marcondes4, Susana Caballero5, Natalia Botero Acosta7, Fredrik Christiansen4, Julian Castrillon9, Ari Friedlaender10, So Kawaguchi11, Mike Double12, Masato Moteki13, Ryosuke Makabe14,

Phylogenetically controlled life history trait meta-analysis in cetaceans reveals unexpected brain size and longevity patterns

Nikita Groot1, Rochelle Constantine2, Ellen Garland3, Emma Carroll4
1The University of Auckland, Auckland, New Zealand, 2School of Biological Sciences, University of Auckland, Auckland, New Zealand, 3University of St. Andrews, United Kingdom, 4University of Auckland, Auckland, New Zealand
Nils Hoem15, Michele Burford16, Susan Bengtson Nash17
1Southern Ocean Persistent Organic Pollutants Program, Griffith University, Salisbury, Queensland, Australia, 2Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, Australia, 3Marine Information and Research Group–Australia (MIRG), Quinns Rocks, Australia, 4UMR ENTROPIE Institute of Research for Development, Noumea, New Caledonia, 5Instituto Baleia Jubarte, Caravelas, Bahia, Brazil, 6Universidad de los Andes, 7Macuáticos Colombia Foundation, Medellín, Antioquia, Colombia, 8Aarhus Institute of Advanced Studies, Aarhus, Denmark, 9Griffith University, Nathan, QLD, Australia, 10University of California Santa Cruz, Santa Cruz, California, 11Australian Antarctic Division, Australian Marine Mammal Centre, Kingston, Tasmania, Australia, 12Australian Marine Mammal Centre, Australian Antarctic Division, Hobart, Australia, 13National Institute of Polar Research, Tokyo, Japan, 14National Institute of Polar Research, Tokyo University of Marine Science and Technology, Tokyo, Japan, 15Aker BioMarine Antarctic AS, Lysaker, Norway, 16Australian Rivers Institute, School of Environment and Science, Griffith University, Nathan, Queensland, Australia, 17The Southern Ocean Persistent Organic Pollutants Program, Griffith University

Isoscapes of Southern Ocean marine ecosystems are not uniform, varying spatially and temporally due to regional and seasonal gradients in biogeochemistry, productivity and oceanography. Euphausiids in the Ross and Amundsen seas have significantly higher δ15N values but lower δ13C values than zooplankton from the West Antarctic Peninsula. This is despite phytoplankton δ15N and δ13C values not differing significantly between these regions. On the other hand, phytoplankton δ15N values are known to vary temporally, with baseline δ15N values being higher during bloom peaks (austral summer) than during the austral winter. Understanding and accounting for such spatial and temporal variations in isoscapes at the base of the Antarctic ecosystem is particularly important for accurate interpretation of diet in high-fidelity Antarctic krill (Euphausia superba) consumers, like southern hemisphere humpback whales (Megaptera novaeangliae). We analysed Antarctic krill sampled in different Southern Ocean regions, together with skin biopsy samples of five distinct southern hemisphere humpback whale breeding stocks, to assess if spatial differences in Antarctic krill δ13C and δ15N isoscapes match spatial differences in humpback whale δ13C and δ15N isoscapes. Krill samples were collected in the austral summer preceding winter biopsy sampling, ensuring a temporal within-year match. As each southern hemisphere humpback whale breeding stock is thought to utilise distinct Antarctic feeding grounds, we hypothesised that the diet of the breeding stocks would reflect krill isotopic profiles from their putative feeding ground. Evaluating inter.population variability in isotopic profiles in relation to prey isoscapes in Antarctic feeding grounds allows us to refine conclusions about the diet of humpback whales and provide supporting evidence for feeding ground locations for the individual breeding stocks.

Reconstructing Annual Abundance Trends of Humpback Whales at an Oceanic Migratory Stopover

Thomas Grove1, Ruth King2, Andrew Stevenson3, Lea-Anne Henry4
1University of Edinburgh, Edinburgh, United Kingdom, 2School of Mathematics, University of Edinburgh, Edinburgh, United Kingdom, 3Humpback Whale Film and Research Project Bermuda, Smiths

Baleen whales are sensitive to ecosystem change and human activity. Most species undertake long-distance migrations, which may span entire ocean basins. As such, baleen whale abundance trends may facilitate ecosystem assessment at
large spatial scales. Efforts to reconstruct abundance trends have, so far, focused on the ‘end points’ of migration. To our knowledge, we present the first assessment of abundance trends at an oceanic, migratory stopover. Bermuda is a stopover for North Atlantic humpback whales, with migratory connections to nearly all major feeding and breeding grounds. To estimate the annual abundance of whales visiting Bermuda, we used photo-identification capture-recapture data collected between 2010 and 2020. We combined a Cormack-Jolly-Seber (CJS) model with Horvitz-Thompson estimator to calculate abundance; and stratified bootstrap resampling to derive 95% confidence intervals (CI). We accounted for temporal heterogeneity in sighting probability via a catch-effort model, utilising the recorded number of sighting effort days. Further, guided by goodness-of-fit testing, we specified models which account for transience and individual detection heterogeneity (IDH). A model which incorporated sighting effort and transience, but not IDH, provided the best fit (lowest AIC) and narrow confidence intervals for all parameter estimates. The survival of non-transient animals was 0.99 (CI 0.95-1); annual detection ranged from 0.05 (CI 0.03-0.07) in 2020 to 0.16 (CI 0.11-0.21) in 2019; and the rate of transience declined annually, from 0.63 (CI 0.53-0.69) in 2011 to 0.47 (CI 0.38-0.56) in 2020. Abundance varied from 690 (CI 538-911) in 2016 to 1505 (CI 1182-2045) in 2018 and increased slightly across the period. However, there were large fluctuations between consecutive years, with a 48% decline in abundance from 2015 to 2016. Due to Bermuda’s migratory connections throughout the North Atlantic, this time series may be used to monitor species response to ecosystem change across an entire ocean basin.

A deep-diving anomaly in optimal foraging theory: Cetacean spleen specialization and depth-dependent apnea

Sabrina Groves, Mount Holyoke College, National Museum of Natural History (USNM), Northern Virginia Community College

Of the air-breathing vertebrates, cetaceans are the deepest and longest divers; displaying an incredible physiological response to facilitate their marine lifestyle. Under apneic conditions, a controlled onset of bradycardia reduces cardiac output and oxygen consumption; peripheral vasoconstriction counteracts a drop in blood pressure while preferentially redistributing blood; and rapid splenic contraction releases oxygenated blood stores. Despite substantial circulatory shifts, prolonged dives defy optimal foraging models because they are metabolically inefficient, requiring large oxygen stores, energy, and recovery times that exceed the benefits of average meals. To consistently surpass predictions, cetaceans must either possess a more oxygen-efficient system or employ oxygen reserves beyond those accounted for. One overlooked possibility is the role of spleen specialization, and accompanying polysplenia, in dive type diversity. This study presents data on 69 extant species, with 765 specimens ranging in number (1-14 accessory) and function (reservoir, metabolic, and hematopoietic). Across dive types, reservoir characteristics were most common, serving as the primary tissue in 68% of species. In contrast, polysplenia observations were highly correlated with preferred depth: Deep divers had the highest prevalence of polysplenia, suggesting that multiple small spleens allow for quick fill times and early contractions, complementing the group’s rapid foraging descents, swift recovery periods, and successive apneas. Deep dwellers exhibited large spleens, which may fulfill combined oxygen and contractile force demands required to circulate blood at depth for prolonged breath-holding periods, followed by leisurely slow-fill recovery intervals. Shallow dwellers showed high spleen variation, perhaps because surfacing is highly behavioral, with minimal travel depth and time constraints. Functional differentiation, of the spleen, represents one possible model for long-
Standing inconsistencies in optimal foraging theory; the data suggest that preferential deep diving may be accomplished by splenic enhancement of the respiratory system, allowing cetaceans to dive further and longer to pursue high-quality prey while conducting aerobic respiration.

**Singing Fin Whale Swimming Behavior in the Central North Pacific**
Regina Guazzo1, Ian Durbach2, Tyler Helble3, Gabriela Alongi4, Cameron Martin1, Steve Martin1, Elizabeth Henderson4  
1Naval Information Warfare Center Pacific, San Diego, CA, 2CREEM, University of St Andrew, St Andrews, United Kingdom, 3U.S. Navy, San Diego, CA, 4National Marine Mammal Foundation, San Diego, CA, 5nmmf, san diego, CA, 6SPAWAR/Navy Marine Mammal Program, San Diego, California

Singing fin whales produce 20 Hz pulses in regular patterns of inter-note intervals, but little is known about fin whale swimming behavior while they are singing. Even less is known about fin whales in Hawaiian waters because they have rarely been sighted during surveys and passive acoustic monitoring has been limited to systems without localization capabilities. We hypothesized that fin whale kinematics may be related to their singing behavior, or to external variables such as time and sea state. To investigate this hypothesis, we analyzed 115 tracks containing 50,034 unique notes generated from passive acoustic recordings on an array of 14 hydrophones from 2011-2017 at the U.S. Navy Pacific Missile Range Facility off Kauai, Hawaii. Fin whales swam at an average speed of 1.1 m/s over relatively direct paths. We incorporated the whales' speed and turning angle into hidden Markov models to identify different behavioral states based on the whales' movements. We found that fin whale behavioral state was related to the vocalization rate (also known as cue rate) and time of day. As cue rate increased and at nighttime, fin whales were more likely to swim slower and turn more. We also examined whether the presence of singing fin whales was related to time and sea state using generalized additive models. Fin whale acoustic presence was affected by day of the year and song season, and possibly also wind speed and wave height. Although the track kinematics from the fin whale tracks presented here are limited to a subset of whales that are acoustically active, they provide some of the only detailed movements of fin whales in the region. Understanding how fin whale behavior varies based on their vocalization patterns, time, and environmental factors will help us to contextualize potential changes in whale behavior during anthropogenic activity.

**The Visual Field of the Bottlenose Dolphin (Tursiops truncatus)**
Tabitha Gunnars1, Rebecca Milner2, Meghan Barnes2, Krysta Walker2, Charles Abramson1, Jason Bruck4  
1Oklahoma State University, Kansas City, MO, 2Dolphin Quest, Sandys, Bermuda, Bermuda, 3Oklahoma State University, Stillwater, OK, 4Stephen F. Austin State University, Nacogdoches, Texas

An expansive field of vision (FOV) in an organism aids in the detection of threats as well as the localization of food and mates, and is often a feature of prey species. In converse, an expansive blind spot, while usually associated with greater binocular vision, can leave animals vulnerable. For example, consequences of blind spots in dolphins include boat strikes which cause injury or death. In odontocetes, we have the unique phenomenon of what is often a predator species with a prey-like eye arrangement. This makes the estimation of the dolphin blind spot difficult from purely anatomical studies and necessitates a psychophysical approach to determine an effective FOV. We predicted that blind spots...
would occur in the area along the dorsal fin based on previous research that indicated a high number of boat injuries to this posterior dorsal region. We also tested claims that dolphins could not see in the frontal area of their rostrum under what we have termed the echolocation replacement hypothesis for dolphin visual fields. Using LED lights attached to a Hoberman sphere, where dolphins were trained to vocalize in the presence of a light turning on, we mapped the effective FOV for the bottlenose dolphin. We failed to find support for the echolocation replacement hypothesis as all three dolphin subjects were able to see anteriorly of their rostrum, but we did find reason to support the idea that dolphins have a significant posterior blind spot, which may explain some of the boat injuries sustained by wild populations. Our results have direct implications for researchers working by boat in close proximity to animals in the wild as well as researchers developing close approach Unmanned Aerial Vehicles for cetacean conservation applications.

Beyond the basics: using photo-identification as tool to assess social behavior and determine the sex of Lahille’s bottlenose dolphins (Tursiops gephyreus)

Raphaela Gurgel1, Rodrigo Genoves2, Pedro Fruet3, Silvina Botta4

1Federal University of Rio Grande (FURG), Rio Grande, Rio Grande do Sul, Brazil, 2Federal University of Rio Grande, Oceanographic Museum of Rio Grande, Rio Grande, Rio Grande do Sul, Brazil, 3Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos, Santos-SP, Brazil, 4Universidade Federal do Rio Grande-FURG, Rio Grande

Although free-living cetacean behavior observation is very limited, scars on odontocetes bodies caused by conspecifics can give us evidences of agonistic behavior and sex-related patterns can even be used as a feature for sex recognition of individuals. The current work analyzed all-natural scars on dorsal fins of Lahille’s bottlenose dolphins from Patos Lagoon Estuary, southern Brazil, to evaluate potential sex-specific differences in aggression patterns and develop a statistical model to determine the dolphins’ sex. For that purpose, we selected the highest quality photographs of 36 adult individuals (14 males and 22 females) obtained during photo-identification surveys. Temporary marks were evaluated by the proportion of dorsal fin coverage, plotting the entire fin surface and calculating the scars percentage relative to the dorsal fin area - in pixels - using Photoshop software. Further, the amount of permanent marks and their relative tissue loss (subtle, moderate or significant loss) were also assessed. It was found a significant difference between sexes in prevalence of temporary and permanent marks on the dorsal fin (p<0.001), where males showed a mean coverage by temporary marks approximately four times greater (mean=20.5%, DP=4.8%) than females (mean=5.3%; DP=3.4%), as well as a greater amount and intensity of permanent marks. Finally, a logistic regression was applied in order to find which variables best predict the dolphins’ sex. The proportion of coverage by temporary marks was the only significant predictor, resulting in a highly effective statistical model, with 97% accuracy in determining the sampled individuals’ sex. The results demonstrated a more aggressive behavior among males, probably associated with social competition for access to females. Therefore, the photo-identification technique was proved to be effective in evaluating differences in aggression patterns, as well as in predicting Lahille’s bottlenose dolphins’ sex - what can be explored as a quick, broad and non-invasive sexing method.

Results of mitigation and monitoring program implemented during construction of Coastal Virginia Offshore Wind (CVOW) Pilot Project turbines

Katherine Guttenplan1, Janelle Lavallee2, Scott...
On May 25th and 30th, 2020, Dominion Energy installed two monopiles using impact monopile driving as part of the construction of the two 6-megawatt (MW) wind turbine generators (WTGs) for the Coastal Virginia Offshore Wind (CVOW) Pilot Project. These were the first offshore wind turbines installed in federal waters of the United States. Mitigation and monitoring efforts included monitoring by Protected Species Observers, exclusion zones and clearance procedures, and soft starts, resulting in the successful prevention of harassment of marine mammals during construction. The project also implemented a noise reducing, double Big Bubble Curtain (dBBC) during installation of one monopile and conducted underwater acoustic measurements throughout monopile driving of both monopiles. Two hydrophones, one at 1 meter and another at 12 meters above the benthic surface, recorded at 750, 1500, and 3000 meters from each monopile in order to better understand the potential noise reduction associated with dBBC use during monopile driving activities. This presentation will highlight the overall mitigation and monitoring approach and describe the results of that program, including a discussion of the dBBC system and the noise reduction achieved. It will conclude with key take-ways of this pivotal project and implications for marine mammals and the offshore wind industry, addressing both conservation and regulatory considerations.

Marine mammals are vulnerable to a variety of acute and chronic anthropogenic impacts, including underwater noise disturbance, ship strike and entanglement. The effects of these impacts can vary both inter- and intra-specifically, with some populations and species more vulnerable to certain impacts. However, knowledge of the associated thresholds for disturbance, how often multiple (and simultaneous) exposures occur, how stressors interact, and ultimately what the individual and population consequences of disturbance are for marine mammals is extremely limited. As such, the approach to evaluating this within a formal Cumulative Effects Assessment (CEA) is often to consider the impacts of each stressor separately, though it is evident that assessing stressors independently does not constitute a true appraisal of their cumulative effects. We present the results of a review of >70 CEAs from ten maritime industries considering potential cumulative impacts on marine mammals. Using an objective framework to examine the quality of each assessment allowed for comparison over time and across industries. We found inconsistency in the language used to define and describe cumulative effects, a lack of routinely applied methodology, and an overall disparity in CEA quality across industries. For >75% of CEAs the decision whether impacts were significant (and so requiring appropriate mitigation measures to be taken) was based on practitioner opinion rather than quantitative analysis. The lack of replicability, and the variation in quality between industries, raises uncertainty around the effectiveness of these assessments in preventing significant cumulative impacts. We assessed
CEAs conducted for UK waters as a case study, however our findings are broadly applicable to CEAs globally. Therefore this work is relevant to anyone interested in assessing multiple stressors to marine mammals, from a science or policy perspective.

A multifaceted examination of blubber to infer the nutritional status of the Eastern Pacific gray whale (Eschrichtius robustus)
Barbie Halaska¹, Padraig Duignan², Stephen Raverty³, John Calambokidis⁴, Jessie Huggins⁵, Kia Hayes⁵, Daniel Crocker⁶
¹The Marine Mammal Center, ²The Marine Mammal Center, Sausalito, California, ³The Animal Health Center, Abbotsford, British Columbia, ⁴Cascadia Research Collective, Olympia, ⁵Cascadia Research Collective, Olympia, Washington, ⁶Sonoma State University, Rohnert Park, CA

The eastern North Pacific gray whale (ENPGW) (Eschrichtius robustus) is an emblematic species that uses Arctic waters as its primary foraging grounds and builds blubber stores before embarking on a long migration along the west coast of North America. There is now an urgent need to look further into ENPGW nutrition because of the ongoing unusual mortality event declared in 2019, with malnutrition being one of the most significant findings to date. The nutritional condition of this subpopulation has been examined through photogrammetry and biopsies, but, thus far, has lacked a full thickness blubber analysis to provide further insight into underlying physiology. This presentation will describe a multi-faceted approach that uses 200 individual frozen blubber samples from stranded dead animals with a decomposition code of fresh to moderate and years ranging from 1990 to 2021. The objective of this study is to analyze traits such as adipocyte size and abundance, total lipid content and fatty acid (FA) profiles across sex and age classes to create a nutritional condition profile. The adipocytes within the stratified blubber (outer, inner and mid) will be examined by a gradient to deduce quantity, size, and distribution by means of histology. Age class and sex are especially important to consider to further ascertain how adipocytes and FA are accumulated through different life stages and are the drivers of nutritional condition. FA analysis will reveal shifts in prey usage in association with changes in blubber lipid content and adipocyte morphology. This analysis is crucial to create a nutritional condition profile for the species during their migration and to give further understanding on ENPGW physiology.

Can temperament serve as a predictor of future behavioral diversity in beluga (Delphinapterus leucas) calves?
Jackson Ham¹, Beri Brown¹, Katie Kolodziej², Jenny Mairot-Mendoza², Malin Lilley³, Heather Hill⁴
¹University of Lethbridge, Lethbridge, ²SeaWorld San Antonio, ³Texas A&M University- San Antonio, Jonestown, Texas, ⁴St. Mary’s University, San Antonio, Texas

As part of a longitudinal study of beluga (Delphinapterus leucas) behavior, the temperament of seven calves at Sea World San Antonio (SWSA) were determined over their first two years of life, using a Principal Components Analysis (PCA) of 23 behaviors. The PCA yielded a five-factor model for beluga temperament in the first two years of life. These factors included mother-calf bond, sociability, independence, exploration/vigilance, and curiosity/playfulness. Although temperament did not appear to have fully stabilized by year two, the evidence indicated that calves had distinct temperaments. The purpose of the current study was to determine if specific temperament factors during the first two years of life could be used to predict cognitive abilities, in the form of object play diversity, at three and four years of age. Object play, an understudied form of play, is frequently observed in belugas in managed care
and shows individual variability in frequency and type. Belugas at SWSA were afforded with varied objects including submersible and floating objects. Preliminary results found that only two of the five measures of temperament are significantly correlated with object play. When comparing how many behavioural patterns were in a sequence, only curiosity/play and sociability in the first two years of life are correlated, and negatively so, with the number of behaviors observed in sequence. Although preliminary, this suggests that at least certain measures of temperament may indicate later cognitive abilities, specifically with regards to object manipulation. Other measures of object manipulation/play have yet to be analyzed and may further support our preliminary findings. Understanding the relationship between calf temperament and object play diversity at juvenile ages could serve as an important tool in assessing cognitive developmental outcomes, which may facilitate the management of belugas both in human care and across wild populations.

Population parameters and natural markings in Blainville’s beaked whales (Mesoplodon densirostris) in Madeira Archipelago (NE Atlantic)
Eliette HAMARD¹, Anja Badenas², Rita Ferreira³, Annalisa Sambolino⁴, Marc Fernandez Morron⁵, Ana Dinis⁶, Filipe Alves⁷
¹Aix-Marseille Université, France, ²MARE-Marine and Environmental Sciences Centre, Funchal, Portugal, ³MARE-Madeira, Portugal, ⁴MARE - Marine and Environmental Sciences Centre / ARDITI, University of Madeira, Funchal, Madeira, Portugal, ⁵Portuguese Foundation for Science and Technology, ⁶Universidade dos Açores, Ponta delgada, Azores, Portugal, ⁷MARE/ARDITI/OOM, Funchal, Portugal, ⁸MARE - Marine and Environmental Sciences Centre, Portugal

Beaked whales are among the least studied cetaceans worldwide, therefore knowledge on their population dynamics is scarce. Here, we analysed the proportion of unique identifiable marks and quantified the mark change rates in Blainville’s beaked whales (Mesoplodon densirostris) from photographic identification data collected between 2004 and 2020 in Madeira Island. Around the Madeiran archipelago, the species exhibits both short- (multiple days within the same year) and long-term (seen more than one year) site-fidelity. Additionally, after testing both open or closed population models, we estimated abundance using POPAN and MSORD open models from a truncated dataset (2011 to 2020). Preliminary results showed significant differences in the number of marks between genders (Mann-Whitney U test, p-value=0.003), with (at least) slightly distinctive marks visible on 30% (SE=25%) of females and 73% (SE=44%) of males, considering natural marks both in the body (scars) and in the dorsal fin (nicks). A new mark change was calculated to occur every 0.6 year (range= 0.3-0.9) in females and every 0.9 year (range= 0.4-1.4) in males. Population parameters from both models were consistent and similar, with the POPAN estimating a super-population size of 164 individuals (95% CI: 145-191). Results should be interpreted with caution given the ongoing nature of the analysis, yet they provide novel information on such cryptic species. Especially for the oceanic archipelago of Madeira which seems to constitute an important habitat for cetaceans and where knowledge on beaked whales is limited.

Drones reveal disturbances of harbor porpoises (Phocoena phocoena) by small vessels
Héloïse Hamel¹, Sara Torres Ortiz², Sébastien Lhoumeau¹, Malou Friis Vittrup⁴, Dennis Brennecke⁵, Magnus Wahlberg⁶
¹Marine Biological Research Centre, University of Southern Denmark, ²Max-Planck-Institute for Ornithology, Puerto de la Cruz, Santa Cruz de Tenerife, Spain, ³Université de la Réunion, ⁴University of Southern Denmark, ⁵Kieler
Sound is biologically important for whales to communicate, find prey and navigate underwater using echolocation. With the rise of small recreational vessels, the levels of high-frequency noise have substantially increased in shallow waters, with the risk to affect whales. Toothed whales, such as harbor porpoises (*Phocoena phocoena*), have been shown to be vulnerable to boat noise due to their high sensitivity to high frequencies, but we know little about the details of their reactions to small vessels. Here, we used drones to film interactions between harbor porpoises and boats in shallow waters. We show that most adult porpoises reduced their breathing rate immediately after encountering small boats moving at low speeds. Half of the adults showed clear behavioral reactions by quickly swimming away from the boats and diving for an extended time; with half of the reactions seen within 30 m. In some cases, the porpoises were seen to leave the area after the boat interaction. The calves did not vary their breathing pattern around boats but all of them showed avoidance reactions together with their mothers, with all interactions seen within 30 m. While prolonged dives and erratic behaviors elicited by boats may increase the porpoises’ energy expenditure, a repeated boat noise exposure at close range can temporarily disrupt echolocation, and affect social interactions and foraging efficiency of individual animals. Drone observations showed that small boats navigating close to shore can be a source of disturbance for harbor porpoises that may have been overlooked before. These findings may help to define appropriate guidelines for boat navigation in shallow waters, to mitigate the disturbance in porpoises during encounters.

**Separating overlapping click trains: An updated method for estimating the number of echorocating animals in varied background noise levels**

**Becca Hamilton**\(^1\), Josefin Stakhammer\(^2\), Stefanie Gazda\(^3\), Richard Connor\(^4\)

\(^1\)University of Manchester, United Kingdom, \(^2\)Lund University, Lund, Sweden, \(^3\)University of Florida, Newberry, Florida, \(^4\)University of Massachusetts Dartmouth, North Dartmouth, Massachusetts

Much can be learned by investigating the click trains of odontocetes, including estimating the number of vocalizing animals and comparing the acoustic behavior of different individuals. Analyzing such information gathered from groups of echorocating animals in a natural environment is complicated by two main factors: overlapping echorolocation produced by multiple animals the same time, and varying levels of background noise. Starkhammer et al. (2011) described the click train separation (CTS) algorithm that measures and compares the frequency spectra of individual clicks to group them into click trains, defined as groups of clicks produced by the same animal. This study presents an update to the CTS algorithm that improves performance by comparing multiple click characteristics. There is a focus on reducing error when background noise levels are high and recordings are of a limited frequency bandwidth, making the method applicable to a wide range of existing datasets. Also described is a procedure to remove background noise peaks that get falsely classified as echolocation clicks. This method was successfully tested on recordings of free-swimming foraging dolphins in a noisy natural environment. The algorithm can be adjusted via user-set parameters for application to recordings with varying background noise levels, allowing for estimates of the number of echolocating animals in free-swimming groups from continuous single-hydrophone recordings.
Kin Recognition in Bottlenose Dolphins
Jason Bruck¹, Devon Hill², Rachel Hamrock², Benjamin Taft³
¹Stephen F. Austin State University, Nacogdoches, Texas, ²Oklahoma State University, ³Landmark Acoustics LLC

Kin recognition is an important mechanism to prevent inbreeding in social mammal populations where kin and non-kin cohabitate. While many terrestrial species rely on their sense of smell to differentiate between kin and non-kin, cetaceans do not possess olfaction. Instead, bottlenose dolphins (*Tursiops truncatus*) use individualized contact calls known as signature whistles to transmit social identity information. We utilized familiar signature whistle playbacks to assess kin recognition and discrimination by dolphins housed under human care in a multi-institution breeding consortium. If dolphins can use signature whistles to determine kinship, we predicted that dolphins would display more sustained attention to playbacks of signature whistles of kin over non-kin regardless of familiarity. Testing 43 subjects with known social histories and kinship across six facilities, our results showed that dolphins approached more and maintained attention longer to a speaker producing playbacks of kin regardless of how long the subject and playback dolphin were housed together in the past. Males were also more likely than females to respond to female whistles with approach behaviors, whereas females were more likely to respond to other females’ whistles using vocal responses, regardless of kinship. These results show that coefficient of relatedness is a strong predictor of signature whistle playback responses supporting the hypothesis that the signature whistle system is a principal mechanism for kin recognition in bottlenose dolphins. These results demonstrate how a learned and innovated labeling system in non-human mammals is used to prevent inbreeding and maintain a dynamic fission-fusion social system.

Quantification of flow generated by fast starts in fish with regard to predation by marine mammals
Wolf Hanke¹, Benedikt Niesterok²
¹University of Rostock, Rostock, Germany, ²Institut für Fisch und Umwelt

Fast-starts are performed by fishes for different purposes such as striking at prey or escaping from predators. Our study by Krüger et al. (Journal of Experimental Biology 2018) demonstrated that vortex rings, i.e. certain stable structures of water flow that may be generated by escaping fish, can be detected and analysed by pinnipeds. Here we investigated 47 fast-starts of rainbow trouts (*Oncorhynchus mykiss*) elicited by a startle stimulus. The patterns of water movements left behind by the escaping fish were investigated regarding their possible value as a source of information to piscivorous predators that rely on hydrodynamic sensory systems. Particle Image Velocimetry (PIV) measurements revealed that typically two to three different jets of water flow were produced. Jet 1 was generated by the tail. Jet 2 was generated on the inside of the C-bend during the first stage of the C-start, and by the tail during the second stage. During the second stage, another small jet (jet 3) was often generated by the body. Temporal extensions were up to 25.5 min and spatial extensions were up to 1.53 m (extrapolated) for jet 1. Duration and spatial extension of jet 2, the flow produced by the body, were lower, and both jets differed in size. The fish escaped in a mean direction approximately parallel to jet 1, and antiparallel to jet 2, with a range well above 200 degrees. This study quantified the flow patterns generated by escaping fish and, as piscivorous predators would greatly benefit from being able to analyse these flow patterns, provides cues for the behavioral and physiological investigation of hydrodynamic sensory systems. Additional measurements with a custom designed scanning particle velocimetry device gave additional insight into the spatial
structure of the jets and showed that jet 1 closely approximates a circular vortex ring.

Examining the plasticity of the dive response in relation to dive behavior of northern elephant seals
Shawn Hannah¹, Cassondra Williams², Allyson Hindle¹, Lauren Cooley³, Paul Ponganis⁴, Markus Horning⁵, Holger Klinck⁶, Daniel Costa⁷, Birgitte McDonald⁸
¹Moss Landing Marine Laboratories, ²National Marine Mammal Foundation, San Diego, CA, ³University of Nevada Las Vegas, Las Vegas, NV, ⁴Moss Landing Marine Laboratories, Marina, CA, ⁵Scripps Institution of Oceanography, La Jolla, CA, ⁶Wildlife Technology Frontiers, Seward, Alaska, ⁷Cornell University, Ithaca, New York, ⁸Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, ⁹Moss Landing Marine Laboratories, Moss Landing, CA

Searching and capturing prey are extraordinary challenges for marine mammals, as they must actively hunt during breath-hold dives. This challenge is conquered through a suite of physiological adaptations known as the dive response. The dive response is comprised of breath-hold (apnea), lowered heart rate (bradycardia), and peripheral vasoconstriction. This response increases dive capacity for marine mammals by lowering the rate of oxygen consumption while maintaining physiological homeostasis. Previously considered a strict reflex, the dive response has been shown to be a dynamic response influenced by dive duration, depth, anticipation, and exercise. However, it is still unknown how these influences interact with each other to facilitate oxygen management pre- and post-dive, and during different dive phases. To determine how marine mammals manage their oxygen stores during natural dives and how plastic the dive response is, we studied the dive response of one of the deepest diving marine mammals, the northern elephant seal (Mirounga angustirostris), across three years (2018, 2019, 2021). Using a state-of-the-art physiological biollogger that records electrocardiogram data (ECG, 50-100 Hz) and a Daily Diary time-depth-recorder (TDR) that records acceleration and depth, we calculated heart rate, stroke rate, and fine-scale behavior in 7 seals in dives up to 54 minutes in duration. During the longest dives, heart rate decreased to 3 beats per minute. We review the effects of dive depth, duration, and stroke rate on dive heart rate, pre- and post-dive heart rate, and heart rate during different dive phases. Our results couple dive behavior and the dive response to understand how marine mammals perform deep-dives while actively searching and capturing prey.

The shyest blackfish: Examining the global phylogeography of the pygmy killer whale (Feresa attenuata)
Brittany Hanser¹, Kelly Robertson², Robin Baird³, Patricia Rosel⁴, Antonio Mignucci⁵, Louella Dolar⁶, Lynsey Wilcox⁷, Karen Martien⁸
¹Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, La Jolla, CA, ²Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanographic and Atmospheric Administration, La Jolla, ³Cascadia Research Collective, Olympia, WA, ⁴NOAA Fisheries, Lafayette, Louisiana, ⁵Manatee Conservation Center, Bayamon, Puerto Rico, ⁶Silliman University, Dumaguete City, Philippines, ⁷NOAA Fisheries, Southeast Fisheries Science Center, Lafayette, LA, ⁸NOAA Southwest Fisheries Science Center, La Jolla, CA

The pygmy killer whale (Feresa attenuata) is a historically poorly studied species that is found in oceanic waters and around oceanic islands. The shyest of the blackfish, they are naturally rare, cryptic, and often elusive, making them difficult to study. Reports indicate that they are highly vulnerable to artisanal fisheries bycatch in some areas. To investigate the global genetic
structure of these animals, we sequenced a 671 bp section of the mitochondrial control region of 88 globally distributed samples. Overall haplotypic diversity is $h=0.94 \pm 0.020$, while nucleotide diversity is $\pi=0.0088 \pm 0.0035$. The Atlantic ($n=15$) and Pacific ($n=70$) samples exhibit significant genetic differentiation ($F_{st} = 0.11$, $p$-value $<0.001$, $\Phi_{st} = 0.13$, $p$-value $<0.009$) and do not share any haplotypes, suggesting low gene flow between ocean basins. The most striking result is that three of the four samples from the Philippines (sampled from the Sulu Sea) are very different from all other pygmy killer whales. One sample was taken in a fishery interaction in 1994, and the other two from stranded animals in 1996. These three samples share two haplotypes that are similar to each other and are separated from all other pygmy killer whale haplotypes by five fixed nucleotide differences. The net nucleotide divergence ($d_A$) between the Sulu Sea haplotypes and all others is 0.013, which is higher than that between many recognized cetacean subspecies. In comparison, the $d_A$ for the Atlantic vs. Pacific samples is 0.0013. Further, a Bayesian phylogenetic tree indicates that the divergence time between these two haplotypes, and the rest of the samples is comparable to that between sister species of other blackfish, suggesting the presence of an unrecognized pygmy killer whale subspecies. Further study, including more extensive sampling, is needed in order to better understand and conserve the genetic diversity of this species.

Bottlenose Dolphins Recognize Individual Conspecifics Using Vision Alone
Heidi E. Harley¹, Wendi Fellner², Kim Odell³
¹New College of Florida, Sarasota, FL, ²Disney's The Seas, Epcot, Lake Buena Vista, Florida, ³Disney's Epcot's The Seas, Lake Buena Vista, Florida

Bottlenose dolphins are highly social, and so understanding dolphins requires understanding the mechanisms they use to sustain their social networks. Recognition of individuals is fundamental to dolphin societies, and many studies suggest they use whistles for this task. However, studies of in situ and ex situ dolphins also confirm that they experience hearing deficits including profound hearing loss. Hence, both science and management decisions prompt the investigation of the use of other senses for individual recognition: Can dolphins use vision alone to recognize individual conspecifics? Here we invited an adult male dolphin born in human care and living in a 22-million-liter multi-species environment to engage in a problem-solving task. The invitation was a video sample of an unknown dolphin projected onto a window about 4 m below the water’s surface. If interested, the participant-dolphin investigated the sample-dolphin and then moved to a second window to choose among 3 video alternatives, one of which portrayed the sample-dolphin. Researchers naïve to the sample’s identity identified the participant-dolphin’s choices; when the choice matched the sample, food fish appeared at the water’s surface. Multiple sets of stimuli were presented in 18-trial sessions balanced for sample identity/alternative position. A pairwise comparison analysis revealed near perfect discrimination of some dolphin-video pairs but confusions in others; mean performance accuracy for pairs was 72%, 65%, 53%, 64%, 96%, 96%, 67%, 89%, 42% (chance for pairs=33%). These data confirm that dolphins can use vision alone to recognize individuals, but also that some discriminations are easier than others. This discovery along with previous findings of dolphin visual discrimination of marine species and integration of visual and echoic information highlight the need to consider dolphins’ visual capacities in scientific models and conservation/management decisions as we transform science into stewardship.

Stock Structure, Residency, and Inter-Island Movements of Common Bottlenose Dolphins between Oʻahu and Maui Nui
Annette Harnish1, Robin Baird1, Jens Currie2, Stephanie Stack2, Tori Cullins3, Lynn Opritoiu3, Annie Gorgone4, John Kirkpatrick5
1Cascadia Research Collective, Olympia, WA, 2Pacific Whale Foundation, 3Waiʻanae, HI, 4Beaufort, 5Evergreen State College

Accurate descriptions of population structure are critical to inform effective management of protected species. Here we present the results of a reassessment of the structure and residency of two common bottlenose dolphin (Tursiops truncatus) stocks from the main Hawaiian Islands. Previous photo-identification and genetic studies have shown that bottlenose dolphins in the main Hawaiian Islands live in four small (~100 individuals), demographically independent and genetically differentiated island-associated populations around Kaua‘i/Ni‘ihau, O‘ahu, Maui Nui (Maui, Lāna‘i, Kaho‘olawe, and Moloka‘i), and Hawai‘i. A recent abundance estimate demonstrated that three of these four populations, designated as stocks, show evidence of decline, particularly the Maui Nui stock. However, photo-identification and satellite-tagging data has shown that some individuals do occasionally move between island areas, especially between O‘ahu and Maui Nui. These movements may have important consequences, as even a few dispersing individuals can impact genetic diversity and allow for the transmission of culturally-mediated behaviors. We reassessed the population structures of the O‘ahu and Maui Nui stocks by analyzing over two decades’ worth of photo-identification data representing 472 individuals, and satellite-tag data from five individuals. While we found that social connections between the two populations were minimal, there was geographic overlap in spatial use that crossed stock boundaries. This was caused by a small subset of individuals (n=14) from the O‘ahu population that occasionally travel between island areas, using SW O‘ahu, SW Moloka‘i, and SW Lāna‘i. Satellite-tag data from two suspected inter-island travelers reveals that these animals made extensive use of Penguin Bank, indicating that this area may be of importance to inter-island travelers. Inter-island travelers were sighted in both island areas at all times of the year, though they were consistently sighted more frequently off O‘ahu than off Maui Nui. Further research will be needed to identify the possible drivers of this behavior.

Estimating dose-response functions for cetaceans exposed to naval sonar: does tag choice matter?
Catriona Harris1, Phil Bouchet2, Len Thomas1
1CREEM, University of St Andrews, St Andrews, Fife, United Kingdom, 2University of St Andrews, St Andrews, Fife, United Kingdom

Behavioural response studies (BRS) have significantly advanced our understanding of the sensitivity of various cetacean species to noise, in particular navy sonar. BRSs monitor a suite of behaviours before, during, and after sound exposure with the aim of quantifying the relationship between the level of sound received by an individual and any observed changes in behaviour (e.g., movement, diving, acoustic). Behaviour is typically monitored using animal-borne telemetry tags, such as short-term, high-resolution, DTAGs and medium to long-term, coarse-resolution, position and depth-transmitting satellite tags. Recent studies have combined different tag types in their study design to better characterise the nature and duration of responses relative to baseline behaviours across multiple spatio-temporal scales. However, differences in the quality and resolution of the data derived from each instrument raise important questions regarding the optimisation of their use in BRSs and their role in quantitative assessments of noise impacts. In particular, it is unclear what insights can be drawn from satellite tag data, which are typically collected with varying and occasionally large levels of uncertainty. We simulated the responses of Cuvier’s beaked whales (Ziphius cavirostris) to naval sonar under a variety of experimental
conditions and explored how uncertainty in our knowledge of the acoustic dose received by individuals affects exposure-response relationships. Building on an existing Bayesian hierarchical model, we show that the positional errors associated with modern Argos satellite tags are, on average, sufficiently low to allow useful inference of behavioural responses in beaked whales. Importantly, we also demonstrate that substantial improvements in the precision of model parameter estimates are possible with increased sample sizes, largely independently of tag choice and configuration. These results illustrate the utility of satellite tags for evaluating the effects of anthropogenic sound on marine mammals and inform the design of future BRSs.

Estimating cetacean density using slow-moving autonomous ocean vehicles: a summary of key results from a 4-year research project

Danielle Harris¹, Selene Fregosi², Jay Barlow³, Kalliopi Gkikopoulou⁴, Holger Klinck⁵, David Mellinger⁶, Len Thomas⁷

¹Centre for Research into Ecological and Environmental Modelling, University of St Andrews, St Andrews, United Kingdom, ²Cooperative Institute for Marine Resources Studies, NOAA Pacific Marine Environmental Laboratory and Oregon State University, Hatfield Marine Science Center, ³unaffiliated, San Diego, CA, ⁴Sea Mammal Research Unit, University of St Andrews, St Andrews, Fife, United Kingdom, ⁵Cornell University, Ithaca, New York, ⁶Cooperative Institute for Marine Resources Studies, NOAA Pacific Marine Environmental Laboratory and Oregon State University, Hatfield Marine Science Center, Newport, OR, ⁷CREEM, University of St Andrews, St Andrews, Fife, United Kingdom

A recent project (2015-2019) funded by the US Office of Naval Research focused on cetacean density using passive acoustic data recorded by autonomous underwater vehicles such as ocean gliders. The major advantage of gliders and similar autonomous vehicles over other platforms used for marine mammal monitoring (e.g., ships or fixed acoustic recorders) is their ability to provide both spatial and temporal coverage of an area during a survey. The project’s overall goal was to develop a general framework for estimating cetacean density from data collected by autonomous ocean vehicles. Key aspects of survey design, data collection and data analysis were investigated using ocean glider data from multiple locations. First, surveys undertaken in the Gulf of Alaska, the Mariana Island Range Complex and the Hawaii Range Complex were used to assess the effect of ocean glider movement on distance sampling assumptions and survey design. Second, cetacean tracking data from the US Navy’s Atlantic Undersea Test and Evaluation Center and the Southern California Offshore Range were used to estimate the probability of detecting vocalizations of both fin whales (Balaenoptera physalus) and Blainville’s beaked whales (Mesoplodon densirostris). Third, data recorded in the Catalina Basin, off the Californian coast, were used to investigate detection probabilities of Cuvier’s beaked whales (Ziphius cavirostris) by a glider using an array of surface drifting recorders. Here, key methods and results across the project are presented and discussed. In particular, detection probabilities were estimated using a variety of methods: spatial-capture recapture, trial-based (using independent localizations of animals as trials) and simulations. In conclusion, ocean gliders can be used to estimate cetacean densities, though their slow movement and only being equipped with a single hydrophone (in general) required existing density estimation methods to be adapted for this new type of survey platform.

Using structured expert review to delineate and score Biologically Important Areas (BIA 2) for cetaceans in waters off the United States

Megan Ferguson¹, Sofie Van Parijs², Jolie Harrison³, Leslie New⁴, Reny Tyson Moore⁵, Ei
Biologically important areas (BIAs) represent areas and times in which cetaceans are known to concentrate for activities related to reproduction, feeding, and migration, and also the known ranges of small and resident populations. This effort aims to update and revise the BIAs for cetaceans identified in Van Parijs et al. (2015), adding new BIAs where appropriate. It will identify the full extent of any BIAs that overlap U.S. waters, rather than truncating boundaries at the U.S. Exclusive Economic Zone. Here, we outline the methodology that regional cetacean experts are using to delineate and score BIAs in this NOAA-led, Navy-supported expert working group, as well as the structured elicitation principles applied. The new BIA scoring and labeling system, which will improve the utility and interpretability of the BIAs, designates an overall Importance Score that considers two components: 1) the intensity and characteristics underlying an area’s identification as a BIA; 2) the quantity, quality, and type of information, and associated uncertainties, upon which the BIA delineation depends. Each BIA is also scored for boundary uncertainty and spatiotemporal variability (dynamic, ephemeral, or static). BIAs are compilations of the best available science and have no inherent regulatory authority. They have been used by NOAA, other federal agencies, and the public to support planning and marine mammal impact assessments, and to inform the development of conservation measures for cetaceans.

Phthalates are chemical esters used as additives in common consumer goods, such as plastics, household cleaners, and personal care products. Phthalates are not chemically bound to the items to which they are added and can easily leach into the surrounding environment. Anthropogenic drivers, such as coastal plastic pollution and wastewater runoff, increase the exposure potential for coastal marine fauna. Phthalate exposure in free-ranging bottlenose dolphins has been the focus of recent study, with indications of heightened exposure to certain phthalate compounds. The objective of this study was to compare urinary phthalate metabolite concentrations among bottlenose dolphins (Tursiops truncatus) sampled in Sarasota Bay, FL, to levels reported in human samples collected as part of the Centers for Disease Control and Prevention’s (CDC) National Health and Nutrition Examination Survey (NHANES). Monoethyl phthalate (MEP) and mono-(2-ethylhexyl) phthalate (MEHP) were the most prevalent metabolites detected in dolphin urine (n = 51; MEP = 29.41%; MEHP = 54.90%). The geometric mean (GM) concentration of MEP was significantly lower for dolphins (GM = 4.51 ng/mL; 95% CI: 2.77–7.34 ng/mL) compared to humans (p<0.05), while dolphin concentrations of MEHP (GM = 4.57 ng/mL; 95% CI: 2.37–8.80 ng/mL) were significantly higher than levels reported in NHANES (p<0.05). Health impacts to bottlenose dolphins resulting from elevated exposure to the MEHP parent compound...
(diethyl-2-ethylhexyl phthalate, DEHP) are currently unknown. However, given the evidence of endocrine disruption, reproductive impairment, and abnormal development in humans, pursuing investigations of potential health effects in exposed bottlenose dolphins would be warranted.

Vulnerability of North Atlantic right whales to entanglement and collision in the Gulf of St. Lawrence: insights from their diving behaviour
Valerie Harvey¹, Veronique Lesage², Russel Andrews¹, Catherine Johnson³, Jean-François Gosselin⁴, Arnaud Mosnier⁴, Sophie Comtois⁴, Kevin Sorochoan⁴, Stéphane Plourde⁶
¹Fisheries and Oceans Canada, Mont-Joli, Quebec, ²Fisheries and Oceans Canada, Mont Joli, Quebec, ³Marine Ecology and Telemetry Research, Kingston, WA, ⁴Fisheries and Oceans Canada, Dartmouth, NS, ⁵Fisheries and Oceans Canada, Mont-Joli, Québec, ⁶Fisheries and Oceans Canada, Mont-Joli, NS

The North Atlantic right whale (NARW) population is highly endangered and currently declining, mainly as a result of vessel strikes and entanglement in fishing gear. In recent years, about one third of the population summers in the Gulf of St. Lawrence, Canada. High anthropogenic mortalities were reported in this area in 2017 and 2019, however, vessel strike and entanglement risks remain poorly understood. We used satellite-linked time-depth/fastlocGPS Argos transmitters to assess these risks in the southern Gulf of St. Lawrence by documenting NARW diving behavior in relation to the vertical distribution of their prey, obtained from a Video Plankton Recorder. Nine tags were deployed in August 2019 for periods ranging from 10 min to 6.2 d (median: 9 h), including four which provided nighttime data. NARW diving behaviour differed between day and night, and was influenced by the diel vertical distribution of copepods. During daytime, NARW spent on average 32% of their time near the surface (< 12 m), possibly involved in surface active groups, and more than 50% of their time near the seabed (75—101 m) where the densest aggregations of their main prey (Calanus hyperboreus and C. finnarchicus) were observed. At night, when Calanus spp. were more dispersed throughout the water column, NARW spent on average 72% of their time within 6 m from the surface, with only 15% time spent diving near the seafloor. While quantitative risk models will be needed before firm conclusions can be reached, we highlight two important findings: NARW are particularly at risk of entanglement in fishing gear due to their tendency to forage near the seafloor during daytime, and particularly at risk of collision during nighttime given the large proportion of time spent near the surface during this period when visual detection is largely inefficient.

Distribution and habitat preferences of Indo-Pacific bottlenose dolphins (Tursiops aduncus) inhabiting coastal waters with mixed levels of protection
Rebecca Haughey¹, Timothy Hunt², Daniella Hanf³, Maria Cecilia Passadore Real⁴, Ryan Baring⁴, Guido J. Parra⁵
¹Cetacean Ecology, Behaviour and Evolution Lab, Flinders University, Perth, WA, Australia, ²Cetacean Ecology, Behaviour and Evolution Lab, Flinders University, Adelaide, SA, Australia, ³Cetacean Ecology, Behaviour and Evolution Lab, Flinders University, Australia, ⁴Independent, Punta del Este, MALDONADO, Uruguay, ⁵Cetacean Ecology, Behaviour and Evolution Lab, Flinders University, Bedford Park, SA, Australia

Assessments of species distributions are crucial for informing conservation and management action. In this study, we used ensemble modelling to explain the distribution of Near Threatened Indo-Pacific (IP) bottlenose dolphins...
(Tursiops aduncus) in coastal waters at the North West Cape (NWC), Western Australia (WA), an area encompassing a marine protected area and adjacent unprotected coastal waters. Analyses used dolphin sighting data collected during boat-based surveys conducted from 2013 to 2015 and 2018 to 2019. Overall, the distribution of IP bottlenose dolphins was best explained by distance to coast (up to 2000 m) and distance to boat ramp (up to 7000 m). Areas of high probability of occurrence for dolphins extended from the tip and down the eastern side of the NWC and overlapped with designated sanctuary zones as well as waters beyond the boundaries of the Ningaloo Marine Park (NMP). Distribution and habitat preferences varied slightly with season. This study highlights the importance of inshore areas of the NWC for IP bottlenose dolphins and the potential vulnerability of this species to increasing and cumulative anthropogenic stressors associated with these areas. Results of this study should be considered in future zoning reviews and adaptive management efforts of the NMP allowing for effective management of this Near Threatened species.

Large vessel activity and low-frequency underwater sound benchmarks in United States waters

Samara Haver1, Jeff Adams2, Leila Hatch1, Sofie Van Parijs4, Robert Dziak5, Joseph Haxel6, Scott Heppel7, Megan McKenna2, David Mellinger8, Jason Gedamke8

1Oregon State University/CIMERS, 2NOAA Fisheries, Silver Spring, Maryland, 3Stellwagen Bank National Marine Sanctuary, Scituate, Massachusetts, 4NOAA NMFS NEFSC, Woods Hole, MA, 5NOAA-PMEL, Newport, OR, 6PNNL, Sequim, Washington, 7Oregon State University, 8Cooperative Institute for Marine Resources Studies, NOAA Pacific Marine Environmental Laboratory and Oregon State University, Hatfield Marine Science Center, Newport, OR, 9NOAA Ocean Acoustics Program, Silver Spring, Maryland

Chronic low-frequency noise from commercial shipping is a worldwide threat to marine animals that rely on sound for essential life functions. Although the U.S. National Oceanic and Atmospheric Administration recognizes the potential negative impacts of shipping noise in marine environments, there are currently no standard metrics to monitor and quantify shipping noise in U.S. marine waters. However, one-third octave band acoustic measurements centered at 63 Hz and 125 Hz are used as international indicators for underwater ambient noise levels driven by shipping activity. We apply these metrics to passive acoustic monitoring data collected over 20 months in 2016-2017 at five sites throughout U.S. waters: Alaskan Arctic, Hawaii, Gulf of Mexico, Northeast Canyons and Seamounts Marine National Monument (Northwest Atlantic), and Cordell Bank National Marine Sanctuary (Northeast Pacific). To verify the relationship between shipping activity and underwater sound levels, vessel movement data from the Automatic Identification System were paired to each passive acoustic monitoring site. Daily average sound levels were consistently near to or higher than 100 dB re 1 µPa2 in both the 63 Hz and 125 Hz one-third octave bands at sites with high levels of shipping traffic (Gulf of Mexico, Northeast Canyons and Seamounts, and Cordell Bank). Where cargo vessels were less common, daily average sound levels were comparatively much lower (~10-30 dB depending on the season in Hawaii and the Alaskan Arctic). Although these band-level measurements can only generally facilitate differentiation of sound sources, these results demonstrate that international acoustic indicators of commercial shipping can be applied to data collected in U.S. waters as a unified metric to approximate the influence of shipping as a driver of ambient noise levels, provide critical information to managers and policy makers about the status of marine environments, and to identify places and times for more detailed
investigation regarding environmental impacts.

**Saving whales and fisheries, one less rope at a time. NOAA’s role in evolving ropeless fishing**

Sean Hayes¹, Michael Asaro², Colleen Coogan³, Brian Galvez⁴, Caroline Good⁴, Christin Khan⁴, Robert Martin⁴, Eric Matzen⁴, Henry Milliken⁴

¹NOAA NEFSC, EAST FALMOUTH, MA, ²NOAA Fisheries GARFO, Gloucester, MA, ³NOAA Fisheries NEFSC, Woods Hole, Massachusetts, ⁴NOAA - Office of Protected Resources, Silver Spring, MD, ⁵NOAA Fisheries, East Falmouth, Massachusetts

Eliminating vertical lines in fishing gear to reduce entanglement is a decades old concept with a variety of names including pop-up, on-demand, buoyless, and most commonly ‘ropeless’. In the fall of 2017, after a year of unprecedented mortality for North Atlantic right whales, NOAA Fisheries and collaborators recognized it was time to stop thinking of ropeless as a futuristic solution, and began a program to develop ropeless fishing under commercial fishing conditions. This accelerated in 2019 when Congress allocated funding with the mandate to develop technologies to reduce entanglement in North Atlantic right whales. This program was built on the foundation that supporting collaborations between fishermen, engineers, scientists and conservationists is the best way to advance ropeless technology to ensure that fishermen have an alternative to wide scale seasonal fishing closures. Step one was to facilitate gear development and testing by creating policy to allow for gear testing, funding fishermen to test gear, and building a ‘gear library’ for fishermen to trial various ropeless systems and suggest improvements (i.e. trial, break and trial again, see abstract by Moore et al on testing results). Step two involves developing buoyless gear tracking and reducing gear conflict, which means replacing the century old method of communication with surface buoys to something more akin to ‘Google maps’ for the ocean floor with near-real-time gear locations provided to fishers, nearby vessels, and enforcement. NOAA Fisheries continues to work with numerous partners to facilitate the development of ropeless fishing gear, communication networks, cloud database infrastructure, standards, acoustic communication for underwater geolocation, regulatory policies, and social acceptance. The final step is building momentum, both economic and social, for this technology to be affordable and functional, fulfilling our mission to facilitate the coexistence of our precious cultural fisheries, coastal communities and stewardship of marine resources.

**Comparative Large Whale Occurrence And Habitat Use In The Gulf Of California, As Derived From Satellite Telemetry**

Craig Hayslip¹, Daniel M. Palacios², Barbara Lagerquist³, Thomas Follett², Ladd Irvine³, Maria Esther Jimenez Lopez³, Jorge Urban⁴, Bruce Mate²

¹Oregon State University, Newport, OR, ²Oregon State University, Newport, Oregon, ³Universidad Autonoma de Baja California Sur, Mexico, ⁴Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico

The Gulf of California is a marginal sea of the North Pacific Ocean that hosts important whale populations, including seasonally migratory blue whales (*Balaenoptera musculus*) from the adjacent eastern North Pacific; year-round-resident fin whales (*B. physalus*); and sperm whales (*Physeter macrocephalus*) that are part of the population that roams the greater eastern tropical Pacific. We conduct a synthesis of long-term tagging datasets to describe occurrence and habitat use in the Gulf by blue (n=16; 1999-2016), fin (n=11; 2001), and sperm (n=44; 2007-2008) whales. We used implantable Argos-monitored tags to track the movements of these species over multiple months. Blue whales
occupied the Gulf seasonally between November and March and were distributed along its entire length with locations highly concentrated in the deep central basins and along its western side, although the timing and extent of their occupancy varied substantially between years. Fin whales were tracked from March through September and displayed a seasonal progression in their occupancy, moving from the southwestern Gulf in the early part of the year to the northeastern part in summer, followed by a return to the southwestern part in the fall. Finally, sperm whales were tracked in all months of the year, but their distribution was concentrated in the central Gulf. TDR archival tags attached to some sperm whales reported 77% of dives to depths > 300 m with mean dive durations lasting 25.4 min (SD = 14.2 min), and some individuals were tracked diving to the seafloor at depths of 450-950 m. In conclusion, although there was some overlap in their distribution, these three large whale species occupied distinct habitats in the Gulf, indicating that they likely use different resources and foraging strategies. The observed interannual differences suggest that oceanographic events may be important drivers of large whale occurrence in the Gulf.

Seasonal trends in the Arctic’s marine soundscape in the Kitikmeot Region of Nunavut, Canada as shipping routes become more accessible

Annika Heimrich1, Francis Juanes2, William Halliday3, Stephen Insley3
1University of Victoria, BC Canada, 2University of Victoria, Victoria, 3Wildlife Conservation Society Canada

The Arctic Ocean is an ecologically important ecosystem, offering either a temporary or long-term habitat for numerous migrating and resident marine mammal species every year. Characterised by the annual cycle of sea ice, the Arctic Ocean has less noise disturbance from anthropogenic activities than other marine areas. However, as climate change causes longer ice-free periods during summer, and ship traffic continues increasing, underwater noise in the Arctic may increase in the future. Given that the underwater soundscape is a crucial habitat feature for marine mammals, it is important to monitor this environment.

This study will present the first year-round soundscape analysis based on passive acoustic data collected in the Kitikmeot Region of Nunavut, Canada, using data recorded between August 2017 and March 2019. > 500 hours of acoustic data were analysed for vocalizations by marine mammals, and patterns in underwater sound levels and ship noise were also examined. Ringed seal (Pusa hispida) vocalizations were present consistently in every month of the year, whereas bearded seal (Erignathus barbatus) vocalizations were present between October and August, but peaked during the breeding season in May and June. Beluga whale (Delphinapterus leucas) vocalizations were only detected on a single day in October 2017. Underwater sound levels were strongly driven by wind speed, sea ice concentration, and ship noise however, ship noise only occurred between August and October. Ringed seal vocalizations were detected nearly every day (89.06%) that ship noise was detected, whereas bearded seal vocalizations were only detected on 10.94% of days with ship noise (N = 64), which suggests that ringed seals are exposed to high amounts of ship noise.

This study presents the first long-term passive acoustic measurements in the Kitikmeot Region, and can be used as baseline for future studies on underwater noise within this region.

Fin Whale Song Patterns Shift Over Time in the Central North Pacific

Tyler Helble1, Regina Guazzo2, Elizabeth Henderson3, Cameron Martin4, Gabriela Alongi4, Steve Martin5, Ian Durbach6
1U.S. Navy, San Diego, CA, 2Naval Information Warfare Center Pacific, San Diego, CA, 4SPAWAR/Navy Marine Mammal Program, San Diego, CA, 5Naval Postgraduate School, Monterey, CA, 6U.S. Navy, Monterey, CA
We used passive acoustic recordings from an array of 14 hydrophones to analyze the song patterns of 115 fin whale encounters made up of 50,034 unique notes off Kauai, Hawaii from 2011 to 2017. Fin whale singing patterns were more complicated than previously described. Fin whales off Hawaii sang in five different patterns made of two 20 Hz note types and both singlet and doublet inter-note interval patterns. Some of these song patterns were unique to these fin whales in Hawaiian waters, while others were similar to song patterns recorded from fin whales off the U.S. west coast. Individual fin whales often utilized several different song patterns which suggests that multiple song patterns are not necessarily indicators of different individuals or groups. The dominant song pattern also changed over these years. Cultural transmission may have occurred between fin whales in Hawaiian waters and off the U.S. west coast.

The first record of a continuous multi-day association between a primary escort and female in Hawai‘i

Elizabeth Henderson¹, Mark Deakos¹, Daniel Engelhardt²
¹SPAWAR/Navy Marine Mammal Program, San Diego, California, ²HDR Inc., Virginia Beach, Virginia

In 2019, four humpback whales were satellite tagged off the island of Kauai while part of the same competitive group. The female and primary escort left the competitive group together, and then traveled together from Kauai to Oahu over four days before the female’s satellite tag stopped transmitting. The dive behavior of the competitive group and dyad were analyzed in detail, and the movement behavior of the dyad was modeled using a continuous-time correlated random walk to smooth and interpolate the track and then a Hidden Markov Model to determine the behavioral state. During male competition, although the males always surfaced with the female, they often surfaced more frequently and the primary escort synchronized his surfacings with each challenger. During the following four-day period of association, the movement and dive behavior of the dyad was highly synchronized, with the primary escort closely following the female’s dive behavior except during a few periods when the dyad may have been joined by additional males. This is the longest record of a continuous association between a male and female humpback whale on the Hawaiian breeding grounds. The strong synchrony in their movement and dive behavior provides important insights into the behavior of breeding humpback whales, and may provide some baseline information for the behavior of other satellite tagged humpback whales.


Allison Henry¹, Dee Allen², Amanda Bradford³, Jim Carretta⁴, Tim Cole⁵, Edward Lyman⁶, Nancy Young⁷
¹Northeast Fisheries Center National Oceanographic Administration, Woods Hole, ²Marine Mammal Commission, Bethesda, Maryland, ³Pacific Islands Fisheries Science Center, NOAA Fisheries, Honolulu, Hawaii, ⁴La Jolla, ⁵Northeast Fisheries Science Center National Oceanic Atmospheric Administration, Woods Hole, MA, ⁶NOAA Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, HI, ⁷NMFS Alaska Fisheries Science Center

Nationally consistent classification of human-caused injury and assessment of severity helps identify regional differences in conservation and management needs for marine mammals. In
2012, the U.S. National Marine Fisheries Service (NMFS) published guidelines for assessing marine mammal injuries to address regional inconsistencies in population assessments mandated by U.S. law. These guidelines define a serious injury as one more likely than not to result in death and were created based on binomial tests of known outcome injury reports (2004-2008; n=176) from the U.S. North Pacific, U.S. North Atlantic, and Atlantic Canadian Maritimes. We subsequently evaluated all available determinations of injury severity for baleen whales reported injured in the U.S. North Pacific (2007-2018; n=301) and the U.S. North Atlantic and Atlantic Canadian Maritimes (2000-2018; n=732) to assess if there were regional differences in injury types or application of the guidelines. We found that while application of the guidelines was consistent nationwide; there were regional differences in reported injuries. The U.S. North Pacific (specifically Alaska and Hawaii) had higher rates of vessel interactions, which may be due to greater self-reporting by mariners in those regions. The U.S. North Atlantic and Atlantic Canadian Maritimes had more records with known outcomes of injury, which is attributable to long-term studies of populations of individually identified whales with high site fidelity. Entanglement in fishing gear was the predominant injury across all regions, which likely reflects the ubiquity of the entanglement issue or the often cryptic nature of sublethal vessel strike injuries. Data from additional years have been added to the original dataset, and application of random forest decision trees from to quantitatively assess risk of serious injury and death are being explored.

An analysis of the feeding cycle of an adult female dugong (Dugong dugon) was conducted in order to understand the carbon cycle related to dugong feeding behavior. This was a non invasive study of a single captive dugong in the Toba Aquarium in Japan and the study covered two months of observations (1 January – 11 March 2019). During this period, the daily seagrass consumption, leftover food, the excretion of faeces and urine in the water column were measured. For this adult female dugong, we assumed that there was zero growth rate of body mass during the experimental period. Based on these observations, we quantified the food conversion efficiencies of the captive dugong with the ultimate aim to better understand the role of dugongs in the blue carbon cycle. From a daily intake of seagrass, the left overs were between 4.50 - 8.07% of the food, corresponding to 0.743 ± 0.317 Kg C/day. The majority –between 77.9-85.5% of the intake was respired, corresponding to 9.163 ± 1.074 Kg C/day, about 0.798 ± 0.066 Kg C/day (or 6.58 – 7.74%) was turned into urine, and 0.595 ± 0.382 Kg C/day (2.25 - 7.44 %) was turned into feces. This implies that the far majority of carbon intake is respired directly through CO2 with limited contributions to blue carbon. The latter will mostly be related to the production of feces that might get deposited on the sediment floors of oceans to remain there for a long period of time. With our estimates, upscaling of the dugong’s contribution to blue carbon can be facilitated.

Carbon distribution in daily diet of a Dugong in Toba Oceanarium, Toba, Japan
Sekar Herandarudewi1, Peter Bodegom2, Hans Iongh3, Kotaro Ichikawa4, Yoshihito Wakai5
1Research Center for Oceanography, Indonesian Institute of Sciences, Indonesia, 2CML-Leiden University, Netherlands, 3CML- Leiden

Temporal habitat displacement of an Antillean manatee caused by a mayor hurricane in Puerto Rico
Edward Hernandez1, Antonio Mignucci2
1Caribbean Manatee Conservation Center, Cataño, PUERTO RICO, Puerto Rico, 2Manatee Conservation Center, Bayamon, Puerto Rico
Health assessments of the Antillean manatee (*Trichechus manatus manatus*) population in Puerto Rico provide ecological insights which ultimately help with conservation strategies for the species. The use of ultra-high frequency transmitters to track their movements allow a broader understanding of habitat usage and movement patterns. In 2017, three Antillean manatees were captured as part of a manatee health assessment project in Jobos Bay, Puerto Rico. One was fitted with a satellite tag with the primary objective to gather information on habitat usage and movement patterns. The satellite tag data was frequently visualized using Google Maps and QGis. We extracted parameters such as underwater percentages, underwater dives, tag tilts, GPS coordinates, tag temperature for statistical analyses. The manatee frequently used an area of 6.9 km² in the southern part of Jobos Bay, and occasionally used other parts of the bay. Two to four times per month, the individual traveled for a total period of 48 to 60 hours out to a specific location 8.2 km away from Jobos Bay. On 20 September 2017, Hurricane Maria, a category 4 hurricane, entered the southeast coast of Puerto Rico with a wind speed of 250 km/h and a storm tide of 2.7 m. The manatee moved 18.5 km towards the landfall point of the hurricane in Puerto Rico. It took the individual six days to return to the usual home range at Jobos Bay. The pre-hurricane behavior of habitat usage resumed after the hurricane event. The movement pattern caused by Hurricane Maria on this individual provides us with insights into how the manatee population of Puerto Rico copes with the impact of major hurricane disturbances. To our knowledge, this is the first documented case of the manatee movement during a major hurricane disturbance in Puerto Rico.

Does foraging behavior explain variance in northern elephant seal lifetime reproductive success?
Keith Hernandez¹, Daniel Crocker³, Daniel Costa³, Roxanne Beltran⁴
¹Oregon State University, Santa Cruz, California, ²Sonoma State University, Rohnert Park, CA, ³Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, ⁴University of California Santa Cruz, Felton, CA

Variability in lifetime reproductive success (LRS) is constrained by lifespan in species that produce a single offspring per year. Given the difficulties in determining causes of mortality in marine mammals, understanding behaviors that confer a long lifespan can circumvent this problem. In northern elephant seals (*Mirounga angustirostris*) a small number of females have disproportionately contributed to pup production over several decades. While the mechanisms behind this disparity were not investigated, it was suggested that variability in diet or foraging behavior could contribute. We investigated the links between different drivers of variability in foraging behavior and LRS in northern elephant seals. For 151 females that were instrumented on the post-molt foraging trip, we examined potential relationships between LRS, lifespan and proxies of spatial use, diet, trip timing and body condition gains using linear mixed-effects models. We also determined if post-molt foraging trip characteristics are repeatable behaviors (greater inter- than intra-individual variability) for a subset of individuals. There were no significant relationships between LRS and these drivers of foraging behavior. While there was not a relationship between track overlap or maximum distance traveled and LRS, the median distance traveled from the coast was repeatable within individuals (mean intraclass correlation = 0.67), though track overlap was less repeatable (mean intraclass correlation = 0.24). The lack of relationships between LRS and these drivers lends support to the notion of environmental and ecological variability having a strong influence on adaptive foraging behavior in individual seals. These results suggest that environmental variability and individual
stochasticity play a larger role than foraging behavior in lifetime reproductive success in northern elephant seals.

Rhythm in Cetacean Vocalizations
Taylor Hersh¹, Hal Whitehead²
¹Dalhousie University, ²Department of Biology, Dalhousie University, Halifax

Rhythm—the ordered and recurrent alternation of sounds and silences in a sequence—can help animals increase the transmission fidelity and information content of their vocalizations. It may be a particularly effective tool for taxa that live in complex acoustic environments and use vocalizations as their primary mode of communication, like cetaceans. Despite the impressive ability of vocal rhythm to modulate attention, memory, and synchronization, past research has largely been restricted to humans, songbirds, and non-human primates. Here, we use a systematic approach to synthesize the current state of knowledge on cetacean vocal rhythms and interpret the trends under a comparative lens, resulting in the first infraorder-level assessment of vocal rhythm to date. Our findings suggest that rhythm is a common feature of cetacean vocalizations. This prevalence likely reflects several key features of cetacean biology and ecology, including the need to learn and remember complex vocal displays; the dynamic and cluttered acoustic environment in which cetaceans live; and the benefits of synchronization across various behavioral contexts. In mysticetes, vocal rhythm is largely restricted to song: it may help singers learn and remember songs and allow receivers to predict and attend to salient song features. In odontocetes, the rhythmic faculties gained with the evolution of echolocation have likely been exapted to serve additional functions, resulting in rhythm across a greater diversity of vocalization types. By quantifying rhythm in diverse species, expanding our technical toolbox, and being more intentional in how we describe vocal rhythm, cetacean researchers can better understand the significance of rhythm for the species we study and contribute to a rapidly growing and interdisciplinary body of work on the adaptive value of rhythm.

Model-based estimates of humpback whale vessel strike risk
Eleanor Heywood¹, Caroline Good², Allison Henry³, Heather Lynch⁴, Lesley Thorne⁵
¹SUNY Stony Brook, ²NOAA - Office of Protected Resources, Silver Spring, MD, ³Northeast Fisheries Center National Oceanographic Administration, Woods Hole, ⁴Stony Brook University, Stony Brook, NY, ⁵Stony Brook University, Southampton, New York

Large whales on the highly urbanized U.S. East Coast are vulnerable to vessel collisions, which are one of the leading anthropogenic causes of mortality. Research on ship strike lethality has focused on large vessels, but recent studies have suggested that smaller passenger and recreational vessel activity should be examined when assessing risk of vessel strike. The likelihood of mortality from such collisions is a complex function of spatiotemporal co-occurrence, vessel size, and speed. Since 2016 there has been an ongoing Unusual Mortality Event for humpback whales (Megaptera novaeangliae) along the Atlantic Coast of the U.S. Though the cause of the unusually high number of strandings remains unknown, vessel strikes are thought to be one of the main contributing factors. Atlantic states with the highest reported strandings of humpback whales include New York, New Jersey, Massachusetts, Virginia, and North Carolina, states that are home to some of the busiest ports on the U.S. Eastern seaboard. To examine the relationship between vessel traffic patterns and reported vessel interactions with large whales, we calculated annual vessel density and speed from the Nationwide Automatic Identification System from 2014-2019 for the Mid-Atlantic and Northeast coasts out to 50 nm from shore. Using
the NOAA database of reported large whale vessel interactions in the region over the same time period, we summarized total interactions and the total integrated number of miles traveled for each vessel category (e.g., tug, tanker, cargo, passenger, and fishing) within each region and within designated vessel speed classes (e.g. \(>=10\text{kts}, >=15\text{kts}\)). We fit a Poisson regression to estimate the risk of vessel-related collisions associated to each vessel category. We discuss the implications of our findings for understanding how vessel type and vessel speed influence the risk of vessel strike in humpback whales in busy coastal waterways.

**Acoustic Characteristics Of Narwhal (Monodon monoceros) Social Sounds In Eclipse Sound, Eastern Canadian Arctic: Evaluating Potential Communication Masking By Commercial Ship Noise**

Eva Carolina Hidalgo Pla\(^1\), Joshua M. Jones\(^1\), Kristin Westdal\(^1\), Sean Wiggins\(^1\), John Hildebrand\(^1\)

\(^1\)Scripps Institution of Oceanography, La Jolla, CA, \(^2\)Oceans North, Winnipeg, Manitoba, \(^3\)Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA

Eclipse Sound, Nunavut, Canada is a summering ground for a large population of narwhal. Rapid increases in commercial shipping in this region have raised concerns about potential interference with narwhal acoustic communication resulting from the underwater noise generated by ships. The degree to which ship noise and narwhal acoustic signals overlap in frequency is investigated to evaluate communication masking. Narwhal echolocation clicks and social sounds (i.e. burst-pulse calls and whistles) are detected in acoustic recordings from July-October 2018-20 at two locations in Eclipse Sound. Acoustic characteristics of narwhal sounds are described. Measurements of underwater noise from the four most common types of large ships in Eclipse Sound reveal substantial overlap between ship noise and narwhal burst pulse and whistle calls at distances of 10 or more km from some ships. Echolocation clicks also overlap with high-frequency ship noise at distances of one km or more in some cases. This study adds detail to our understanding of Eclipse Sound narwhal acoustic communication and echolocation and highlights the need to further evaluate the risk of communication masking in narwhal as a result of underwater noise from ships.

**Manatee use of thermal refugia and potential for year-round occupancy in the northern Gulf of Mexico**

Elizabeth Hieb\(^1\), Carl Cloyd\(^2\), Kayla DaCosta\(^3\), Ruth H. Carmichael\(^4\)

\(^1\)Dauphin Island Sea Lab, \(^2\)Dauphin Island Sea Lab, Dauphin Island, AL, \(^3\)Dauphin Island Sea Lab/University of South Alabama, \(^4\)Dauphin Island Sea Lab/ University of South Alabama, Dauphin Island, Alabama

In recent years, sightings of West Indian manatees have increased in the northern Gulf of Mexico (nGOM), but physiological intolerance of water temperatures \(< 20\text{°C}\) have historically limited manatee use of nGOM waters year-round. To survive sustained cold periods, manatees use warm water refuge sites primarily located in peninsular Florida; however, use of thermal refugia outside of Florida combined with climate-driven increases in regional water temperatures may affect the timing and duration of manatee occurrence in the nGOM. To identify potential warm water refugia, we conducted aerial thermographic surveys and collected environmental data at cold season (Nov – Mar) manatee sighting locations in Alabama (AL), USA. To further define conditions under which manatees may use refugia, we compared the timing and distribution of manatee sightings to environmental conditions that may affect the quality and necessity of warm water sources. Thermal anomalies were detected at various sources including an electric generating
plant, wastewater treatment plant, groundwater springs, and temperature inverted haloclines in dredged waterways. Documented manatee sightings at or near locations of thermal anomalies support use of these sites as at least passive refugia (discontinuous warm water source ≥ 20°C). Cold season manatee sightings in AL waters have increased during the last decade, primarily through increased sightings during the late fall and early winter (Nov – Jan) that correspond to increased regional water temperatures during the same time period. Manatees may use passive thermal refugia to remain in the nGOM longer, delaying seasonal migrations to Florida or overwintering as conditions allow. Changes in overall population size, habitat and resource availability, and climate may alter manatee occurrence and distribution, facilitating range expansion that should be considered to support management and recovery actions for manatees across their range.

Trade-offs in prey quantity and quality in gray whale foraging
Lisa Hildebrand†, Kim Bernard‡, Florence Sullivan§, Rachael Orben¶, Leigh Torres#
†Marine Mammal Institute, Oregon State University, ‡College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, OR, §Pacific Whale Foundation, ¶Marine Mammal Institute, Department of Fisheries & Wildlife, Newport, OR, #Marine Mammal Institute, Oregon State University, Newport, Oregon

To forage optimally, predators face complex decisions regarding target prey distribution, quantity, and quality. We pair theodolite tracking of gray whales (Eschrichtius robustus) in Port Orford, Oregon, USA, with concurrent sampling of their zooplankton prey to examine foraging decisions relative to prey quantity (abundance) and quality (caloric content). We test the hypotheses that whales (1) feed more than search or transit in areas with high quantity and quality prey, and (2) select foraging habitat dominated by the calorically rich mysid Neomysis rayii. Relative prey abundance was assessed through standardized image analysis of camera drops, and zooplankton prey community was determined from net tows. These data were spatially interpolated and modeled to generate daily layers of species-specific prey abundance and calories (20 m grid) for comparison to whale behavior derived from tracking data. Whales fed significantly more in areas with higher prey abundance and calories than where they searched and transited. Whales increased foraging effort as overall prey availability increased, yet foraging probability was significantly correlated with quantity and quality of the mysid Holmesimysis sculpta, which has significantly lower calories than N. rayii. However, during the study period, the maximum abundance of N. rayii was 4 times lower than that of H. sculpta and never reached the quantity threshold determined by a logistic regression needed to support whale foraging behavior. Hence, gray whale prey selection involves trade-offs between prey quantity and quality to maximize energetic gain, and prey quality should be considered alongside abundance in ecological studies investigating predator decision-making.

Flexibility in behavior by killer whales during an “innovate” task
Heather Hill†, Myriam Weiss‡, Brasseur Isabelle§, Alexander Manibusan³, Irene Sandoval⁴, Todd Robeck⁴, Julie Sigman⁵, Kristen Werner⁶, Kathleen Dudzinski⁷
†St. Mary’s University, San Antonio, Texas, ²MarineLand Antibes, ³Marineland Antibes, Antibes, France, ⁴St. Mary’s University, San Antonio, TX, ⁵SeaWorld and Busch Gardens Reproductive Research Center, San Diego, CA, ⁶SeaWorld of Texas, ⁷Dolphin Communication Project, Port Saint Lucie, Florida

Thinking flexibly is a skill that enables animals to adapt to changing environments, which
enhances survival. Killer whales, *Orcinus orca*, as the ocean apex predator display a number of complex cognitive abilities, especially flexible thinking or creativity when it comes to foraging. Nine killer whales from two different facilities were trained to respond to an “innovate” cue, in which a behavior different from the previous behaviors was necessary to elicit a reward. The killer whales ranged in age from 5 – 29 yrs with 4 females and 5 males. The results indicated that the killer whales demonstrated flexibility in their behaviors. At the individual level, younger animals demonstrated more variable behaviors as compared to the older animals. Males displayed less complex and lower energy behaviors as compared to the females overall but age or size of the animal may have also contributed to these differences. While these results support existing evidence that killer whales are dynamic in their thinking and behavior, additional research is needed to better understand the factors influencing the emitted behaviors.

**Estimating Vital Rates for Cook Inlet Beluga Whales Using a Novel Multi-Event Mark-Recapture Model**

Gina Himes Boor1, Tamara McGuire2, Amanda Warlick3, Rebecca Taylor4, Sarah J. Converse5, John McClung6, Amber Stephens7

1Montana State University, Bozeman, Montana, 2Aqua Wildlife Research, Anchorage, AK, 3University of Washington, Seattle, 4Alaska Science Center, USGS, 5USGS WA Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, WA, 6The Cook Inlet Beluga Whale Photo-ID Project, Anchorage, Alaska, 7The Cook Inlet Beluga Whale Project

Understanding the survival and reproductive rates of a population is critical to determining its long-term dynamics and viability. For some hard-to-study species, obtaining the typical mark-recapture data used to estimate these vital rates can be difficult, if not impossible. This can be particularly true for reproductive rates if offspring are not always detected, cannot be definitively associated with a particular female, or remain with females for multiple years and cannot be aged with certainty. Data with these complexities cannot currently be used to estimate reproductive rates under existing modeling frameworks. To address this, we developed a Bayesian multi-event mark-recapture model that uses all available adult and adult-offspring sightings, including sightings with older offspring of uncertain age. We applied this model to photo-ID data collected between 2005 and 2017 from an endangered population of beluga whales (*Delphinapterus leucas*) that resides in Alaska’s Cook Inlet. Despite many years of study and over a decade of legal protections, the population continues to decline, and considerable uncertainty remains about its demographic rates. Using our modeling framework, we estimated reproductive and survival rates for breeding females, survival rates for dependent calves and non-breeding individuals, and apparent survival for older calves. Our results suggest that Cook Inlet belugas may not be reproducing as frequently as other beluga populations and that non-breeders may be experiencing low survival rates. Both of these factors may be contributing to the population’s continued decline. This model is foundational to ongoing efforts to estimate trends in demographic rates and abundance in an integrated population model framework to examine population viability, quasi-extinction risk, and explore what stressors might be contributing to the population’s continued decline. Our new modeling framework may be useful for studying other long-lived species whose life history and/or habitat may constrain the data available to model population demography.

**Marine Mammal Bycatch Risk Assessment in Chile**

Ellen Hines1, Maritza Sepulveda2, Carlos Montenegro3, Luis Cocos4, Fernanda Barilari5, Claudio Bernal1, Ilia Cari3, Ljubitza Clavijo1, K.
Alexandra Curtis, Bethany Frantz, Marisol Garcia Reyes, Jorge Guerra, Daisy Hui Shi, Rebecca Lent, Jaime Letelier, Sergio Lillo, Jaime Matera, Daniel M. Palacios, Luis Parot, María José Pérez Alvarez, Marcelo San Martín, Macarena Santos-Carvallo, Benjamin Suarez, Marguerite Tarzia, Christian Vargas, Rodrigo Vega, Patricia Zarate.

In many countries, fisheries bycatch of marine mammals is poorly monitored or regulated. Data gaps in fishing effort, bycatch rates, the fate of animals post-capture, and abundance and trends of affected populations are key obstacles that impede risk assessment of bycatch and constrain management action. Working with governments that rely on fisheries exports to reduce bycatch has been a driver for the creation of the open-source Bycatch Risk Assessment (ByRA) toolbox, which can be used to create spatially explicit bycatch risk analysis. This GIS toolbox allows the spatial/temporal assessment and visualization of bycatch risk using any amount or type of data, identifying areas for critical research and management actions while accounting for uncertainty in toolbox results. In Chile, there is a critical information gap about distribution and abundance for most marine mammal species, and except for sea lions, a lack of data on species that are most affected by fisheries bycatch. Our collaborative project with Chilean stakeholders, including fisheries agencies and national and international scientists is analyzing existing data, and generating methods to characterize the spatial and seasonal distribution and abundance of fishing boats, gear, and marine mammals. We have chosen 18 fisheries of presumptive high bycatch risk nested in four larger regions along the coast of Chile, including industrial and artisanal fisheries. Additionally, in artisanal fishing communities, we will conduct interviews to increase socioeconomic and cultural understanding of small-scale fisheries and bycatch. ByRA results will provide Chilean agencies with information on areas and seasons of bycatch risk, and levels of risk for various fishing gear, which can inform future research and management. By selecting diverse sites as input for our risk assessment framework, we will maximize the capacity of personnel for the applied management of fisheries and marine mammal bycatch in Chile and other countries.

Trophic Analysis of Long-Finned Pilot Whales (Globicephala melas edwardii) in New Zealand Waters: Insights from Mass-Strandings

Beth Hinton, Sarah Bury, Karen Stockin, Emma Betty.

Tiburon, CA, 1Centro de Investigación y Gestión de Recursos Naturales (CIGREN), Universidad de Valparaíso, VINA DEL MAR, Chile, 2Instituto de Fomento Pesquero, Valparaíso, Chile, 3Subsecretaria de Pesca y Acuicultura, Valparaíso, Chile, 4Universidad de Valparaíso, Valparaíso, Chile, 5NOAA Southwest Fisheries Science Center, La Jolla, CA, 6Estuary & Ocean Science Center, San Francisco State University, Tiburon, California, 7Farallon Institute, Petaluma, California, 8International Whaling Commission, United Kingdom, 9California State University, Channel Islands, Camarillo, California, 10Oregon State University, Newport, Oregon, 11Escuela de Medicina Veterinaria, Universidad Mayor; Laboratorio de Ecología Molecular, Instituto de Ecología y Biodiversidad, Facultad de Ciencias, Universidad de Chile; Centro Investigación Eutropia; Millennium Institute Biodiversity of Antarctic and Subantarctic Ecosystems (BASE), Santiago, Chile, Chile, 12Instituto de Fomento Pesquero, Viña del Mar, Chile, Chile, 13Centro de Investigación y Gestión de Recursos Naturales (CIGREN), Universidad de Valparaíso, Viña del Mar, Chile, 14International Whaling Commission, Impington, United Kingdom

In many countries, fisheries bycatch of marine mammals is poorly monitored or regulated. Data gaps in fishing effort, bycatch rates, the fate of animals post-capture, and abundance and trends of affected populations are key obstacles that impede risk assessment of bycatch and constrain management action. Working with governments that rely on fisheries exports to reduce bycatch has been a driver for the creation of the open-source Bycatch Risk Assessment (ByRA)
Knowledge of cetacean foraging ecology is important to identify their overlap and potential interactions with commercial fisheries. However, despite the high frequency of long-finned pilot whale (LFPW; *Globicephala melas edwardii*) strandings on the New Zealand coast, their diet and foraging habitat remains poorly understood.

To assess LFPW diet, and how it may relate to commercial fisheries within New Zealand, we examined stable isotopes of carbon (δ13C) and nitrogen (δ15N) in skin samples from a total of 125 LFPWs (67 females and 58 males) that mass-stranded at Farewell Spit in 2009 (n=20), 2011 (n=20), 2014 (n=27) and 2017 (n=20) and at Stewart Island in 2010 (n=19) and 2011 (n=19). Multivariate analyses were applied to determine variability in δ13C and δ15N by sex, stranding event, year, or location of stranding event. Data were pooled across years and/or locations to assess variation in maturity, age, total body length and reproductive status. Although similar within stranding events, LFPW δ13C values were significantly more depleted in 2014 and 2017 compared to other years, and varied with age and total body length. LFPW δ15N values were significantly higher in 2017 than at other stranding events suggesting these individuals may have been feeding at a higher trophic level in 2017 or that the nitrogen baseline in 2017 may have been higher than in other years. No difference was found in δ13C or δ15N values between sexes.

Differences in isotopic values of LFPWs in New Zealand waters both within and between stranding events are explored relative to stomach content analysis of the same individuals. Findings are further discussed in both the context of international studies and the New Zealand commercial fishery for arrow squid.

### Using 3D Models to Improve Volumetric Estimates of Large Whales and Identifying the Minimum Required Morphometric Measurements to Accurately Estimate Body Volume

Nathan Hirtle1, Julia Stepanuk1, Eleanor Heywood2, Fredrik Christiansen3, Lesley Thorne4

1Stony Brook University, 2SUNY Stony Brook, 3Aarhus Institute of Advanced Studies, Aarhus, Denmark, 4Stony Brook University, Southampton, New York

Studies of body size and condition are key to understanding the health, bioenergetics, and life history of cetaceans. The use of unoccupied aerial vehicles (UAVs) to obtain morphometric measurements of cetaceans at sea has revolutionized the study of cetacean morphometrics and body condition. However, current methods for assessing body condition from UAV data generally require a large number of measurements to accurately represent body shape, which can limit sample size due to water quality or image characteristics (e.g., part of the body contour obscured by water spray). We use 3D models to generate estimates of body volume for humpback whales (*Megaptera novaeangliae*) from UAV measurements to assess which and how many morphometric measurements are required for accurate body volume estimates. We further compare the error between volume estimates derived from 3D models and mathematic equations. We develop 3D models of humpback whales using Blender, an open-sourced software, and UAV measurements of body length and body widths at 5% intervals collected in the Northeast United States between 2018 and 2021. To assess the contribution of specific morphometric measurements to volumetric estimates, we assess the error produced by all combinations and numbers of the 18 morphometric measurements obtained from UAV images (131,072 combinations). Error in volume estimates from 3D models was <5% when generated with as few as five dorsal width measurements, far fewer than required when using mathematic equations. We suggest that by conserving the external morphology of cetaceans rather than approximating morphology using...
Mathematic equations, 3D models present a major advantage for estimating body volume and body condition, especially from photos where the entire body is not visible. We present guidelines for which and how many measurements are needed to accurately capture the morphology and volume of humpback whales and describe how this approach could be applied to other species.

**Cetacean Threats in Taiwanese Waters: Insights from 21 Years of Stranding Data**

Yun Ho¹, Katarina Ekelund¹, Cheng-Tsung Tseng¹, Wei-Lian Qi¹, Jack Wei-Cheng Yang², Chio-Ju Yao²

¹Institute of Ecology and Evolutionary Biology, National Taiwan University, Taipei, Taiwan, ²Conservation Medicine Lab, Dept. Vet Med, NTU, Taipei, Taiwan

Cetaceans stranding record in Taiwan, including the main island and five remote islands, from 2000 to 2020 was collected and analyzed. A total of 1438 stranding events were identified, affecting 1764 individuals. There was a significant upward trend in annual stranding events in the main island, highly associated with the rapid increase in recent years. The year 2013 was shown to be the changing point in temporal pattern, indicating significant difference between the two time periods (2000-2013: 43.4±9.6, 2014-2020: 69.4±16.9). *Kogia sima* (annual average number: 4.6±3.6), *Grampus griseus* (3.2±2) and *Tursiops truncatus* (3.1±2.2) were the major species stranded in the main island before 2013, but the species composition changed after the turning point, with *Tursiops truncatus* (12.3±6), *Neophocaena* spp. (9.7±4.8) and *Lagenodelphis hosei* (6.4±2.7) being the top three ranking species. For the cetaceans stranded in remote islands, *Neophocaena* spp. were the dominant species, accounting for almost 60% of stranding events on average. Causes of death (COD) were identified using data from 2019 and 2020, and it showed that fishery bycatch and disease are the major causes (19% and 23.5% on average, respectively) while the COD of about 50% of stranded individuals was unidentified due to decomposition phenomena. This study indicated that anthropogenic threats to wild cetaceans in Taiwan have a profound effect on the population health and further investigations are warranted.

**Measurement of lumbar vertebral bone mineral density in Indo-Pacific finless porpoise (Neophocaena phocaenoides) using quantitative computed tomography**

Heysen Hei Nam Ho¹, Brian Chin Wing Kot¹, Tabris Yik To Chung¹, Henry Chun Lok Tsui¹

¹City University of Hong Kong & Royal Veterinary College, Tseung Kwan O, Hong Kong, ²City University of Hong Kong, Hong Kong, China, ³City University of Hong Kong, Hong Kong, ⁴City University of Hong Kong, Hong Kong S.A.R., China

Computed tomography (CT) can efficiently and non-invasively retrieve anatomical data and is increasingly used in postmortem assessment of marine mammals, especially cetaceans, to understand their biological and pathological profiles during stranding investigation. Bone mineral density (BMD) is an important parameter that reflects the health condition of an individual cetacean, as BMD plays an essential role in buoyancy and locomotion, as well as indicates nutritional status or diseases. Vertebral osteopathies like spondylitis have been documented in cetaceans. Abnormal BMD is associated with these diseases in humans and may predict their occurrence in cetaceans. Abnormal BMD is also related to malnutrition and pollutant exposure, thus may reflect impacts from anthropogenic changes like prey depletion and environmental pollution. BMD can be measured using quantitative CT (qCT), which offers a better characterisation of cortical and trabecular BMD (cBMD and tBMD) without superimposition and can be efficiently carried out alongside routine clinical or postmortem CT.
scans. However, to our knowledge, standard methodology for the measurement of BMD and reference values have not been established in cetaceans. In this study, we aimed to develop a novel and standardised method of using qCT to measure BMD in the lumbar vertebrae of the Indo-Pacific finless porpoise Neophocaena phocaenoides (NP).

We measured the lumbar cBMD and tBMD in 32 stranded NP from Hong Kong with qCT. We found that cBMD was positively and significantly related to total body length (TBL). Mean cBMD and mean tBMD values in different age groups as classified by TBL are presented (see attached summary) and can be used as preliminary reference values for the evaluation of abnormal BMD and vertebral osteopathies. Overall, we have demonstrated the use of qCT to evaluate BMD in cetaceans and improved the ability of an one-stop virtopsy assessment to that can efficiently and effectively acquire biological health data during cetacean stranding investigations.

Trace Elements in Skin and Teeth of Stranded Bottlenose Dolphins (Tursiops truncatus) in the Northcentral Gulf of Mexico as Short- and Long-Term Indicators of Habitat Use
Matthew Hodanbosi¹, Nathan Miller², Ruth H. Carmichael¹
¹University of South Alabama/Dauphin Island Sea Lab, ²University of Texas at Austin, Austin, Texas, ³Dauphin Island Sea Lab/ University of South Alabama, Dauphin Island, Alabama

Habitat use by the protected common bottlenose dolphin (Tursiops truncatus) in the northcentral Gulf of Mexico is minimally studied yet critical for determining conservation needs. Chemical analysis of inert tissues with continuous growth (e.g., ear bones, baleen, teeth) in marine mammals has enabled habitat use to be inferred in various species. Trace element (TE) ratios can be determined along transects across annual growth layer groups (GLGs) in dolphin teeth to reveal age-specific information about environmental conditions during life. However, because GLG thickness decreases with age, resolution of environmental signatures in newer GLGs is limited. TE data from tissues that turnover rapidly (e.g., skin) can complement data from teeth to elucidate environmental conditions of recent habitats. TE ratios in teeth and skin samples, collected from multiple size- and age-classes of dolphins that stranded in the Mobile Bay/Eastern Mississippi Sound (MB/EMS) system in Alabama during 2011-2019, were analyzed by laser ablation and solution-based inductively coupled plasma-mass spectrometry, respectively. Preliminary data suggest Alabama resident dolphins experience multiple pulses of low-salinity water throughout their lives. Freshwater exposure may be harmful to bottlenose dolphins in the MB/EMS system, causing skin lesions, internal pathologies, and death. This study demonstrates that TE ratios in teeth can be used post-mortem to reconstruct changes in habitat use relative to age and, when coupled with TE data in skin, may enable detection of cases of lethal freshwater exposure, without direct observation during life. If so, archived tissues from stranded cetaceans, if properly preserved, may help to characterize relationships between habitat conditions and mortality.

Marine Mammal Species Diversity off the Eastern Seaboard of the United States
Brooke Hodge¹, Daniel Pendleton², Laura Ganley³, Orla O'Brien¹, Scott Kraus⁵, Ester Quintana-Rizzo⁶, Jessica Redfern²
¹Anderson Cabot Center for Ocean Life at the New England Aquarium, Salem, Massachusetts, ²Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, Massachusetts, ³Burlington, Massachusetts, ⁴Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, ⁵New England Aquarium, Boston, MA, ⁶Simmons University
Marine Protected Areas (MPAs) are a widely-used tool for conserving biodiversity. It has been suggested that areas containing features that are important for marine mammal foraging, including oceanographic stratification, shelf-edge upwelling, and complex topography, be prioritized for protection. On the East Coast of the United States (US), the Northeast Canyons and Seamounts Marine National Monument (hereafter, Monument) was designated to protect ecological connectivity and high diversity for marine mammals and seafloor communities. The Monument is representative of areas known to support marine mammal foraging. However, large-scale assessments of marine biodiversity have not been conducted for the US East Coast. We used four decades of marine mammal survey data, comprising 3,174,167.69 km of survey trackline and 189,175 marine mammal sightings, to calculate a suite of alpha and beta species diversity indices for 500 randomly selected regions between Florida, USA and Nova Scotia, Canada. The regions were identical to the Monuments in size and shape, but their orientation was randomly chosen. Species diversity was calculated using the same amount of survey effort for the Monument and all comparison regions to account for potential bias associated with survey effort (e.g., higher diversity could be associated with areas that have more effort). We used linear models to compare species richness to oceanographic variables and geomorphic features. We found low to high gradients in species richness from south to north, and from inshore to offshore. Waters with higher salinity and colder temperatures, indicative of upwelling, had higher. The alpha diversity in the Monument was within the top 2% of all sites within in our study area. Beta diversity indices indicated that the Monument has unique species composition. Our study provides insights into the factors contributing to high marine mammal species diversity and areas that can be considered for protection.

Shipping noise in the northern Gulf of Mexico between 2010-2020
Lynne Hodge1, Alba Solsona Berga2, Kait Frasier3, John Hildebrand3, Sean Wiggins3, Lance Garrison4, Melissa Soldevilla5
1University Corporation for Atmospheric Research’s (UCAR) Cooperative Programs for the Advancement of Earth System Science (CPAESS) and NOAA, NMFS, Southeast Fisheries Science Center, Baltimore, Maryland, 2Scripps Institution of Oceanography, 3Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, 4Miami, FL, 5Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL

The Gulf of Mexico, home to 21 cetacean species including the endangered Rice’s whale and sperm whale, has high ambient sound pressure levels (SPLs) dominated by low-frequency anthropogenic noise from shipping activity and seismic exploration. Marine mammals rely heavily on sound to navigate, forage, and communicate and can be negatively impacted by chronic elevated noise levels. To determine the contribution of shipping noise to ambient SPLs at six passive acoustic monitoring sites throughout the northern Gulf of Mexico from 2010-2020, we evaluated the number of passing ships, amount of time vessel noise was present, and associated SPLs using a custom MATLAB-based ship sound detector. We linked these detections to Automatic Identification System data to evaluate ship type and proximity effects on SPLs. Preliminary analyses from one year indicate substantially higher numbers of vessels within 20 km of sites located near major shipping lanes (Mississippi Canyon: 5,434 ships; Green Canyon: 2,469). Ships in these two areas with high densities of sperm whales were mainly 50-100 m long and classified as offshore supply vessels. Passenger ships, research vessels, tug tows, and mobile offshore drilling units were also common. The southeastern-most site near the Dry Tortugas had the fewest ships (323), primarily 150-200 m long tankers and cargo
ships and smaller vessels less than 50 m in length, including tug tows. Infrequent ship passings (639 ships) in the Rice’s whale core habitat near De Soto Canyon, beyond the main shipping lanes, were primarily from tug tows and cargo ships less than 100 m in length. The SPL contributions to the ambient soundscape were evaluated by vessel type and proximity. Determining the vessel types, their spatial distribution, and their contributions to the Gulf of Mexico soundscape levels will provide important information toward understanding and reducing impacts on marine mammals from chronic anthropogenic noise sources.

Aging Hawaiian Spinner Dolphins (Stenella longirostris longirostris, HSD) with Two Techniques of Dentinal Aging, Sanding Method and Decalcification & Staining Method, to Gain Population Demographic Information
Jessie Hoffman¹, Kristi West², Ilse Silva-Krott³
¹Hawaii Institute of Marine Biology, Kaneohe, HI, ²University of Hawaii, Kaneohe Bay, HI, ³Annandale, Virginia

Hawaiian spinner dolphins (Stenella longirostris longirostris, HSD) are distributed throughout the Main and Northwestern Hawaiian Islands, subdivided into five separate subpopulations. Though these odontocetes are the most studied small cetacean within Hawaiian waters, very little is known about their population demographics and basic biological information. HSD have a unique diurnal pattern of activity: resting in the shallow, near-shore sandy bays during the day and foraging offshore overnight. Currently, many of these subpopulations are susceptible, and potentially sensitive, to anthropogenic pressures every day due to increased tourism within their resting grounds. With the synergistic effects of climate change and these anthropogenic pressures, aging the HSD population is needed to determine basic parameters of population dynamics, which are crucial to their future success and maintaining/increasing their survivorship. Absolute age can be determined via multiple techniques, the most common for odontocetes being dentinal aging through the counting of growth layer groups (GLGs) in a longitudinal cross-section of the tooth. There are multiple techniques for preparing teeth, the most reliable being decalcifying and staining thin sections of the tooth. However, a newly developed method consists of manually sanding each tooth to see the GLGs without staining, thus minimizing cost and effort time. This study focuses on aging stranded HSD between the years of 2008-2019, to determine: i) ages of the individuals (n=17) stranded within the Hawaiian Islands, ii) generate a growth curve, iii) estimate longevity of HSD, iv) estimate age of sexual maturity for both males and females, and v) look at the viability of the sanding method of dentinal aging, as compared to the decalcification and staining technique, making aging small odontocetes more accessible to stranding and research laboratories.

The Ziggy story: charismatic megafauna and environmental education
G. J. Greg Hofmeyr¹, Simon Mduduzi Seakamela², Kevin Cole³
¹Port Elizabeth Museum at Bayworld, Port Elizabeth, South Africa, ²Department of Forestry, Fisheries and the Environment, Cape Town, South Africa, ³East London Museum, East London, South Africa

In conservation biology it is often noted that “people are the problem”. This is the case with plastic pollution. Changing human behaviour is therefore critical. Successful public awareness campaigns often include charismatic megafauna, which draw attention to problems facing ecosystems or to specific threats. The birth of a southern elephant seal Mirounga leonina outside Port Elizabeth in 2019 was an opportunity to use an individual from a charismatic species to further environmental education. While elephant
seals are regular vagrants to the South African coast, the birth of a pup is an exceptional event. Protecting the pup and mother until weaning required the dedicated effort of a team of volunteers. The pup was named Ziggy and his story was reported in major print and television media in South Africa, and internationally. Once the pup was weaned and his mother had returned to sea, he was captured and housed at Bayworld, a local museum and aquarium for a further six weeks. He was then fitted with a satellite tag and released. Updates of the seal's position at sea, and an informed narrative, allowed the public and local schools to follow his story through traditional and social media over several months. The story attracted followers locally and internationally. The appeal was likely due the seal's visual appearance, his vulnerability, and the fact that he was from a traditionally appealing taxa. His was used as a vehicle to highlight the potential dangers of plastic pollution to the marine environment.

Harbor porpoise acoustic presence and seasonality from the Gulf of Maine to southern New England, USA

Amanda Holdman¹, Annamaria DeAngelis², Sofie Van Parijs³
¹NOAA NMFS NEFSC, Chapel Hill, North Carolina, ²NMFS/NEFSC, Woods Hole, MA, ³NOAA NMFS NEFSC, Woods Hole, MA

Offshore wind energy development is rapidly advancing in United States waters, starting with development in the northeast, requiring monitoring and mitigation of potential impacts to coastal cetaceans. Baseline information on cetacean presence, distribution and abundance is critical for understanding potential impacts on species of concern, particularly for noise-sensitive species such as the harbor porpoise, *Phocoena phocoena*. While broad scale abundance and density estimates are available for harbor porpoise along the northeast region of the United States, these data are at larger scales than the operational impact area for wind energy activities. Passive acoustic monitoring has shown to be an effective method in tracking long-term and broad-scale changes in patterns of marine mammal occurrence across their ranges. Data from 12 echolocation-click detectors (F-PODs) over an 18-month period in 2020-2022 were analyzed to investigate spatial and temporal variation in occurrence and foraging activity of harbor porpoises from inshore Gulf of Maine to southern New England. The F-PODs come with an onboard click classifier that is specifically designed to classify the narrow-band high-frequency clicks harbor porpoises emit (FPOD.exe, version 0.9, Chelonia Ltd.). The dates and times of these clicks were extracted using the F-POD software and were summarized into positive presence minutes (PPM) for foraging and social clicks, which can be distinguished based on the difference in the inter-click-interval. These PPMs were then analyzed for seasonal and diel patterns in clicking behavior. Results from this study provides baseline data on harbor porpoise distribution, seasonal movement patterns and key foraging areas along the northeast Atlantic coast, prior to wind energy development. Sustained data collection in these study areas will be used to identify changes in harbor porpoise acoustic presence related to wind farm construction and/or operation.

Deep diving in a marine heatwave: evidence of a dietary shift in the northern elephant seal

Rachel Holser¹, Luis A. Hückstädt², Daniel Crocker³, Theresa Keates⁴, Birgitte McDonald⁵, Sarah Peterson⁴, Patrick Robinson⁷, Daniel Costa⁷
¹University of California, Santa Cruz, Santa Cruz, CA, ²Institute of Marine Sciences, University of California Santa Cruz, Santa Cruz, California, United Kingdom, ³Sonoma State University, Rohnert Park, CA, ⁴University of California Santa Cruz, ⁵Moss Landing Marine Laboratories, Moss Landing, CA, ⁶University of California Santa Cruz, Davis, California,
Northern elephant seals (*Mirounga angustirostris*) are wide-ranging predators that forage on the abundant biomass of the mesopelagic Northeast Pacific Ocean. Their generalist strategy may buffer the effect of environmental changes on their population. Our 16-year data set was used to examine the effect of the Northeast Pacific Blob 2015 (a marine heatwave that caused extensive ecosystem disturbance) on the distribution, foraging behavior, and body condition of adult female elephant seals. We observed a plastic behavioral response at the population level that corresponded, surprisingly, with unusually high adiposity but normal total mass gain during both annual foraging trips compared to non-heatwave years. There was an increased use of the Alaska Gyre, increased daytime foraging effort, and a substantial increase in deep diving behavior (>800 m depth), consistent with a change in the prey field relative to non-heatwave years. The ability to alter behavior in response to environmental change will be critically important in allowing elephant seals to adjust as the ocean climate changes. Northern elephant seals may be more resilient to a warming ocean than some other predator species, who experienced mass mortality or reproductive failure during the same warming event. Their broad diet and extensive foraging range allow them to succeed where more specialized species do not.

**Interactive threats reduce foraging and prey capture effort by endangered killer whales (*Orcinus orca*)**

Marla Holt¹, Jennifer Tennessen², Bradley Hanson³, Candice Emmons¹, Deborah Giles⁴, Jeffrey Hogan⁵, Eric Ward⁶, Michael Ford⁶, Sheila J. Thornton⁷

¹NOAA Northwest Fisheries Science Center, Seattle, Washington, ²Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, ³University of Washington, Friday Harbor, WA, ⁴Cascadia Research Collective, Olympia, WA, ⁵NOAA Northwest Fisheries Science Center, Seattle, WA, ⁶NOAA Fisheries Science Center, Bellingham, Washington, ⁷DFO - Fisheries and Oceans Canada, West Vancouver, British Columbia

Vessel traffic is a global threat to marine mammals. Vessels can strike individuals, introduce pollutants, disrupt behavior, and generate noise. Moreover, many marine mammals face other threats such as altered prey fields due to anthropogenic factors (e.g. habitat, fisheries, climate change). However, there is often uncertainty regarding what aspects of these threats create the greatest risks given difficulties of studying marine mammal behavior. Here, we use high-resolution animal-borne Dtags to study the behavioral ecology of endangered Southern Resident killer whales that rely on biosonar to hunt Pacific salmon, and investigate how proximate vessels affect foraging behavior and outcomes. We used tag data to identify subsurface behavior, including foraging and prey capture events, to test several vessel and associated sound variables and prey abundance effects on (1) behavioral state occurrence, (2) time spent within each state, (3) transition probabilities among states, (4) the probability of prey capture, and (5) multiple parameters of prey capture dives. Whales made fewer dives and spent less time in prey capture dives, with females more likely to transition to a non-foraging state, when vessels were close (average distance < 400 yd/366 m). Additionally, lower abundance of preferred prey and higher vessel speed reduced the probability of prey capture, empirically confirming the interaction between prey availability and vessel disturbance. Finally, whales descended to depth more slowly while increasing the duration of prey capture dives when vessel emitted navigational sonar but
descended to depth more quickly when foraging with higher broadband noise and closer vessels. We also highlight current efforts to collect additional tag data to better understand foraging behavior and noise exposure over the diel cycle. Findings advance awareness of the negative consequences of vessels, reveal a sex effect on foraging effort, demonstrate an effect of echosounders on foraging behavior, and inform management of endangered species.

Developing a global, standardised qualitative visual health assessment protocol for southern right whales

Sandra Hörbst1, Dr. Claire Charlton2, Emily Gregory3, Fredrik Christiansen4, Steve Dawson5, Philip Hamilton6, Chandra Salgado Kent7, Gianna Minton7, Vicky Rowntree7, Mariano Sironi10, Marcela Uhart11, Caroline R. Weir12, Els Vermeulen13, Heather Pettis14

1Dyer Island Conservation Trust, Gansbaai, Western Cape, South Africa, 2Curtin University Centre for Marine Science and Technology, Western Australia, Australia, 3Pacific Whale Foundation Australia, Australia, 4Aarhus Institute of Advanced Studies, Aarhus, Denmark, 5Otago University, Dunedin, New Zealand, 6Anderson Cabot Center for Ocean Life, Boston, Massachusetts, 7Edith Cowan University, Perth, Australia, 8Independent, Wassenaar, The Netherlands, Netherlands, 9Department of Biology, University of Utah, Salt Lake City, Utah, 10Instituto de Conservación de Ballenas, Buenos Aires, Argentina, Buenos Aires, Argentina, 11University of California, Davis and Universidad del Centro de la Provincia de Buenos Aires, Argentina, Puerto Madryn, Chubut, Argentina, 12Falklands Conservation, Stanley, Falkland Islands, 13Mammal Research Institute Whale Unit, University of Pretoria, South Africa, Hermanus, Western Cape, South Africa, 14Anderson Cabot Center for Ocean Life at the New England Aquarium

Right whales around the world are at risk of mortality and population decline due to reduced health from anthropogenic and biological threats including ship strike, entanglement, gull micropredation and reduced prey availability linked to climate change. Long-term monitoring of southern right whale (SRW, *Eubalaena australis*) populations across the main wintering grounds has revealed fluctuations in sightings and an increase in calving intervals over the last decade. Considering that reproductive success is dependent on body condition and overall health, there is a need to assess SRW condition using standardised and repeatable methods that incorporate various indices. Therefore, a global standardised International Whaling Commission (IWC) endorsed method for the qualitative visual health assessment of SRWs was developed. The method builds on the visual health assessment developed for North Atlantic right whales (*E. glacialis*) and for SRWs in South Africa, and includes the assessment of multiple parameters including body condition, skin lesions (from predatory rake marks, gull micropredation, entanglement, ship strike, other), skin condition (sloughing, cyamids on body) and cyamid infestation around the blowholes. The standardised method considers image quality, scorer agreement analysis and comparison to quantitative aerial photogrammetry morphometric analyses of body condition. A qualitative health assessment using archived and newly obtained photographs from various angles and platforms allows for retrospective and contemporary analysis to understand changes in visually observable correlates of health, particularly over longer time scales. The standardised IWC endorsed protocol allows for global comparison of SRW condition in the various wintering grounds. Understanding the links between apparent condition, reproduction, climate and other anthropogenic stressors will help researchers estimate changes in population demographics to guide species-level assessments and conservation.
Cetaceans first study of four Species summarizing three seasons 2018-2020 in the Bazaruto Archipelago, Mozambique

Roni Horowitz1, Goffman Oz2, Junio Fabrizio Borsani3, Ori Galili4, Kimberly Wood5, Syliva White5, Arie Barouch5, Gil Lupo5, Nurit Eppstein5, Ronit Aboutboul5

1"Koret School of Veterinary Medicine". "The Hebrew University of Jerusalem", 2Haifa University IMMRAC, Haifa, Israel, 3ispra, roma, Roma, Italy, 4Haifa University, Haifa, Israel, 5University of Hawaii, Honolulu, HI

Humpback whale (Megaptera novaeangliae) population boundaries in the Southern Hemisphere have remained largely unstudied. A research team from HRPBM (Humpback Research Project Mozambique) has set out to study the cetacean population around the Bazaruto Archipelago off the western coast of Mozambique, which serves as a winter breeding ground for 3.5 months for the annual migration of C1 whales. Studies were conducted each September from 2018 to 2020. Surveys were carried out aboard small motorboats, 12-13 survey days per season - on suitable weather days. In 2018, the team photographed 63 different individuals, and in 2020 72 distinct individuals. In 2019, no photographs were taken since the Humpback whales had left earlier. Upon reviewing the photos of 2018 and 2020 a pattern emerged - showing multiple individuals with fresh cuts in the same locations on the dorsal fins: below and behind the dorsal fins. Repetitive abrasions at this body location have not been documented in other humpback whale populations. This project provides a preliminary observation of a unique and undocumented region that serves as an important aggregation site for the migratory southern Humpback whale population. It sets the baseline for future studies in this area, in hopes of gathering significant knowledge of the social ecology of the population around this Archipelago in the future. In 2019-2020, the research team collected images of additional species; 17 distinct Humpback dolphin (Sousa plumbea) individuals and examined behavioral patterns of dolphin groups of the following species: Indian Ocean bottlenose dolphin (Tursiops aduncus), Indian Ocean humpback dolphins (Sousa plumbea) and Spinner dolphins (Stenella longirostris). The photographs were measured by the percentage of time in each category: rest, intentional movement for prey, sociableness, and bow riding. We hope that this work will aid in formulating conservation-based guidelines for wildlife interactions that would prevent disturbance and harassment of these animals.

Evidence of two polar bear ecotypes in the Southern Beaufort Sea using compound-specific stable isotope analyses of amino acids

Lara Horstmann1, Malia Smith2, Karyn Rode3, Matthew Wooller1, Raphaela STIMMELMAYR4

1University of Alaska Fairbanks, College of Fisheries and Ocean Sciences, Fairbanks, Alaska, 2University of North Carolina Wilmington, Wilmington, NC, 3USGS Alaska Science Center, Anchorage, Alaska, 4North Slope Borough Department of wildlife management, Institute of Arctic biology UAF, Barrow, AK

The subpopulation of polar bears (Ursus maritimus) in the Southern Beaufort Sea (SBS) has declined concurrent with increases in bear presence and length of stay on shore. We examined long-term patterns in SBS polar bear trophic level and reliance on terrestrially derived carbon over a 65-year period. Polar bear bone collagen samples (n=77) dating from 1954–2019 were analyzed for bulk d13C and d15N values and compound-specific d13CAA values. An additional 50 bone collagen samples from terrestrial mammals and pinnipeds from northern Alaska were analyzed to provide a regional comparative dataset. In polar bears, bulk d13C and d15N values decreased by 2‰ and 1‰, respectively, over the 65-year period. Starting in 2007, the d13C values of isoleucine (-17.9‰±2.2‰), serine (-12.6‰±3.0‰), and glycine (-23.2‰±1.2‰) in...
polar bears approached values of Arctic brown bears (Ursus arctos) (isoleucine: -24.2‰±1.7‰; serine: -7.1‰±2.0‰; glycine: -26.0‰±1.7‰) suggesting that some polar bears are incorporating terrestrial derived carbon at levels similar to those in brown bears. Over our study period, two distinct groups of polar bears were identified based on δ13C values of proline: high δ13Cpro (1.8‰±2.3‰, n=45) and low δ13Cpro (-15.7‰±1.9‰, n=26). The high group had δ13Cpro values similar to brown bears (0.4‰±1.6‰), while the low group approached values of ice seals (-15.3‰±1.2‰). This suggests a dichotomy in SBS polar bear habitats consistent with studies that identified bears ranging farther offshore and those that remain coastal. This study provides evidence of two distinct ecotypes in SBS polar bears, pelagic and coastal, since at least the 1950’s.

**Investigating the temporal bycatch risk for the Indo-Pacific bottlenose (Tursiops aduncus) and Indian Ocean humpback dolphins (Sousa plumbea) in the Menai Bay Conservation Area, Zanzibar, East Africa.**

Holly Houliston¹, Per Berggren², Andrew Temple³

¹Newcastle University, Duffus, Moray, United Kingdom, ²Newcastle University, School of Natural and Environmental Sciences, United Kingdom, ³Newcastle University, MRAG Ltd, London, United Kingdom

Fishing is the primary of income for households in the Menai Bay Conservation Area (MCBA), Zanzibar, East Africa. However, dolphin tourism also contributes to the local economies. In the MCBA, populations of the Indo-Pacific bottlenose (Tursiops aduncus) and Indian Ocean humpback dolphins (Sousa plumbea) have declined by 16% and 63%, respectively between 2002 and 2015 due to bycatch in gillnet fisheries. To mitigate the bycatch risk to dolphins, managers should consider how spatial and temporal changes in dolphin occurrence and fishing effort might influence bycatch risk. This study investigated the temporal variation in bycatch risk to the bottlenose and humpback dolphins in gillnet fisheries in the MCBA. Fishing effort data were collected by observers in two MBCA village landing sites between June 2016 and June 2017. Fishing effort was defined as the number of boats per day that utilised drift and bottom set gillnets. Cetacean click recorders (C-PODs) were deployed between February and April 2013 for 40-66 days, and July-August 2015 for 45 days, at three sites in the MBCA. Detective positive minutes were used as a proxy for relative dolphin occurrence. An array of machine learning techniques, including Facebook Prophet, Random Forest and Gradient Booster classifiers were used to assess the temporal changes in the relative occurrence of dolphins and fishing effort. In turn, the model outputs were contrasted to indicate likely temporal changes in the bycatch risk for the two dolphin species in the MCBA. Fishing effort varied by month and lunar cycle, with the highest effort during the darkest phases of the moon. During the Kusi season and Islamic religious events, the fishing effort was low. The relative dolphin occurrence was highest during hours of darkness and high tide. The bycatch risk was considered greatest when high fishing effort and relative dolphin occurrence coincided.

**Understanding the Distribution Patterns of Rough-Toothed Dolphins (Steno bredanensis) around Kaua‘i and Ni‘ihau**

Marian Howe¹, Robin Baird², Michaela Kratofil³, Daniel Webster²

¹Marine Mammal Commission, ²Cascadia Research Collective, Olympia, WA, ³Cascadia Research Collective, Oregon State University

Rough-toothed dolphins (Steno bredanensis) are one of eighteen odontocete species documented in the Hawaiian Archipelago, and resighting rates indicate that two resident populations likely exist around Kaua‘i/Ni‘ihau and Hawai‘i Island. A
Biologically Important Area (BIA) was established for the smaller Hawai‘i Island population in 2015. We assess spatial use of the Kaua‘i/Ni‘ihau population, which overlaps with U.S. naval activities at the Pacific Missile Range Facility (PMRF), using data from satellite-tags deployed on 18 individuals from 2011 to 2018 (median=10.2 days, range=4-28 days). We estimate home ranges and core use areas of the Kaua‘i/Ni‘ihau population using kernel density estimates generated from dolphin positions every four hours. Tagged dolphins predominantly used the island slopes, at a mean depth of 1,385m (SD=909) and a mean distance from shore of 13.5km (SD=7.9). Dolphins primarily used regions around and between Kaua‘i/Ni‘ihau, although one animal transited to western O‘ahu before returning to Kaua‘i over the course of five days. A ninety-five percent isopleth (K95) of the density estimate was used as a measure of home range, and a 50% isopleth (K50) as a core area indicator. Estimates of K95 and K50 were 11,422km² and 1,014km², respectively. The core area encompasses a steep canyon in the upper section of the channel between Kaua‘i and Ni‘ihau. Nearly half of the core area overlapped with PMRF. Distribution patterns may also vary temporally, as generalized additive models reflected that dolphins generally used deeper waters at night, during winter and fall, and during El Niño-Southern Oscillation events. These findings suggest that the single core area may concentrate prey to allow for more efficient foraging, which in turn may often expose rough-toothed dolphins to sonar and other military operations. Varying solar and lunar light levels and climatic factors may also influence dolphin distribution in the region and on the range.

Comparing Infrared Signatures at Sea of Different Whale Species and Their Behaviors to Mitigate Vessel Strikes with Whales
Laura Howes¹, Scott Kraus², Stephanie Wood³, John Ebersole¹, Jarrett Byrnes⁴
¹University of Massachusetts Boston/Boston

Ship strikes by large vessels are one of the leading causes of serious injury and mortality to whales worldwide. While there have been many measures introduced to mitigate this problem, ship strikes continue. Large ship operators have utilized marine mammal observers, but observers are limited by weather conditions and day-light hours. Previous shipping lane changes and designated speed restriction zones are not a long-term solution because shifts of whale distribution have been documented recently (Davis et al. 2017, 2020). Automatic detection of whales is an additional way for ships to avoid collisions. Infrared imagery has been a recent tool tested for the detection of whales but its limitations proves it not consistent to detect whales in foggy conditions or in humid climates. A multi-tiered detection system that incorporates infrared sensors, passive acoustic monitoring sensors, and georeferenced spatial distribution data, is the best possible solution to create a 24-hour automatic detector of whale blows, flukes, and dorsal fins at the surface. The goal of this research is to create a Bayesian probability spatial map dataset for the Gulf of Maine and Georges Bank of all large whale species, as whale distributions are dynamic and hard to quantify. A comprehensive and dynamic single spatial dataset large whale species is not only important for basic ecological understanding, but also vital for conservation efforts. A variety of data sources from the study area will be combined to create the probability map of georeferenced layers. The second goal of this research is to test and review a multi-tiered autodetection system for accuracy and distance, as well as its capabilities to distinguish specific whale species and behaviors. If a highly accurate and replicable system is created, this has the potential to be a worldwide solution for large whale ship strikes.
Development and evaluation of a field-deployable duplex insulated isothermal PCR for the detection of Toxoplasma gondii in stranded cetaceans
Meng-Jung Hsieh¹, Jack Wei-Cheng Yang²
¹National Taiwan University, Taipei, Taiwan, ²Conservation Medicine Lab, Dept. Vet Med, NTU, Taipei, Taiwan

Toxoplasmosis is a zoonotic disease with veterinary and public health importance worldwide. Toxoplasma gondii (T. gondii) infection in cetaceans is an indicator of land-based biological pollution. Due to the fact that T. gondii diagnoses are often carried out in professional laboratories with non-movable equipment, many case reports were mainly from several countries. For facilitating the global surveillance of T. gondii infection in stranded cetaceans, we developed a field-deployable duplex insulated isothermal PCR (iiPCR) with automated magnetic bead-based DNA extraction for the detection of T. gondii in stranded cetaceans. It targets the B1 gene of T. gondii combined with β2-microglobulin (B2M) gene of cetaceans as an internal control. Compared with conventional real-time PCR assays, B1/B2M iiPCR assay showed comparable clinical sensitivity (770 copies in 25 mg tissue) for the detection of synthetic spike-in standards of T. gondii DNA in cerebrum, cerebellum, skeletal muscle samples. The B1/B2M iiPCR assay coupled with a field-deployable system provides a prompt (~1.5 h), feasible, highly sensitive and specific on-site diagnostic tool for T. gondii in stranded cetaceans, providing one approach to evaluating aquatic ecosystem health and early warnings about negative impacts on human and marine animals.

Dramatic increase in dolphin strandings in Washington State (USA): Brucella and the out-of-towners
Jessie Huggins¹, Dyanna Lambourn², Deborah Duffield³, Dalin D'Alessandro⁴, Erin D'Agnese⁴, Stephen Raverty⁵, Michael Garner⁶
¹Cascadia Research Collective, Olympia, Washington, ²Washington Department of Fish and Wildlife, Olympia, Washington, ³Portland State University, Portland, OR, ⁴D'Agnese EcoConsulting LLC, Portland, OR, ⁵The Animal Health Center, Abbotsford, British Columbia, ⁶Monroe

Few delphinid species call the waters of Washington state home, and the pelagic nature of those that do means few that die at sea become beach cast. Historically, dolphin strandings have been low (<1 per year), and most frequently involved Pacific white-sided dolphins (PWSD, Lagenorhynchus obliquidens). In recent years a dramatic increase in stranded dolphins has been documented, beginning in 2006 (n=3), peaking in 2016 (n=9), and now averaging 4 per year. This increase has been largely driven by an influx of warmer water delphinids not typically seen in the region—common dolphins (Delphinus spp.) and striped dolphins (Stenella coeruleoalba). Common dolphin strandings, which began in 2006 on the outer coast, were followed by live sightings and occasional strandings inside the Puget Sound. Striped dolphin strandings began in 2011 and all occurred on the outer coast. This shift in species composition resulted a shift in seasonality as the peak number of strandings changed from summer and fall to winter and spring. Histologic examination of stranded dolphins (available from 2003 to present) identified lesions resembling neurobrucellosis in 61% of necropsied animals (20 of 33). Samples from 10 of these individuals were positive for Brucella spp. via culture and/or serology, and B. ceti was identified from 4 cultures. Striped and Northern right-whale dolphins (Lissodelphis borealis) appear to be disproportionately infected, with neurobrucellosis suspected or culture-confirmed in nearly all necropsied animals (11 of 12 and 4 of 4, respectively), compared to 6 of 11 examined common dolphins. Although neurologic diseases were found in
PWSD (n=4), they were caused by protozoa or fungi with no signs of *brucellosis*-like disease. Several infected striped dolphins were documented alive at the time of the stranding or presented with evidence of live stranding. These findings suggest that their presence in Washington waters may be the result of debilitation.

Dynamic Association Patterns among Indo-Pacific Bottlenose Dolphins (*Tursiops aduncus*) in Moreton Bay, Eastern Australia, on a Multi-Decadal Timescale

Leonie Huijser1, Barry McGovern2, Ina Ansmann3, B. Louise Chilvers4, Ekaterina Ovsyanikova1, Rebecca Dunlop4, Michael Noad6

1University of Queensland, Australia, 2Pacific Whale Foundation Australia, Hervey Bay, QLD, Australia, 3Massey University, Palmerston North, New Zealand, 4University of Queensland, Brisbane, Australia, 5Cetacean Ecology and Acoustics Laboratories group, School of Veterinary Science, University of Queensland, Dunwich, QLD, Australia, 6Cetacean Ecology and Acoustics Laboratories group, School of Veterinary Science, University of Queensland, Gatton, Australia

Association patterns between individuals may influence genetic diversity, spread of disease, and pathways of information transfer within animal populations. Anthropogenic activities may disrupt association patterns, which may negatively impact population fitness. In several bottlenose dolphin (*Tursiops* spp.) populations around the world, social segregations related to differential interactions with trawler fisheries have been detected. In Moreton Bay (eastern Australia), this segregation disappeared after reduction of commercial trawling. It remains unknown, however, whether trawling drove social segregation in this area or reinforced an underlying population structure. Therefore, this study aimed to assess the longevity and strength of preferred associations between Indo-Pacific bottlenose dolphins (*T. aduncus*) in Moreton Bay on a multi-decadal timescale. Pairwise association rates and different social network metrics were calculated and compared for photo-identified individuals over three periods; 1997–1999 (during trawling), 2008–2011 (after trawling), and 2017–2020 (current). Results showed that social differentiation (i.e., variability in association probabilities among pairs of dolphins) decreased following cessation of trawling. Social networks established for the three periods reflect the previously described community structure during trawling and lack thereof after trawling; dolphins from both former communities were equally distributed over the current network. These findings do not support the hypothesis that trawling reinforced an underlying population structure. Rather, the changes in association patterns likely reflect plasticity in social behaviour, providing resilience in a constantly changing habitat. Therefore, detected social segregations in dolphin populations linked to fisheries may not necessarily indicate disruption of association patterns by these fisheries, but instead correspond to natural levels of behavioural plasticity.

Genome-wide data to investigate manatee taxonomy and hybridization

Maggie Hunter1, Caitlin Beaver1, FABIA LUNA2, Lucy Keith-Diagne2

1Sirenia Project, U.S. Geological Survey, Gainesville, Florida, 2ICMBio/CMA, Santos, SP, Brazil

The evolution and taxonomy of the three extant manatee species is still under investigation. Previous mitochondrial DNA loci divergence dating with strong samples sizes, are contradictory to an analysis with a small number of whole mitochondrial genomes published recently. Some analyses align the Amazonian manatee (Trichechus inunguis) as a sister group to the West Indian manatee (T. manatus), with
the African manatee (T. senegalensis) differentiating earlier; while other analyses indicate that the Amazonian manatee is basal to the West Indian and African manatee. The amount of hybridization between West Indian and Amazonian has also been conflicting depending on the marker, sample size, and analyzed population. There has been some evidence for a ‘hybrid swarm,’ while other studies sampling the mouth of the Amazon and north into Guyana and Venezuela did not find evidence for hybrids. To further investigate these discrepancies on Trichechid divergence, relatedness, hybridization, and genetic structure, we employed a genome-wide genotyping-by-sequencing (GBS) technique, using next generation sequencing. For this study, the three manatee species and two subspecies were represented by 114 manatee samples which were sequenced at ~16,000 GBS loci. Bayesian clustering indicated four primary groups: Florida (with east and west subgroups) and Belize; Brazil and South America; Amazon; and Africa (with north and south subgroups). Phylogenetic analyses suggested similar distances between the three species and a few instances of putative hybrids, potentially making the Amazonian and Brazil groups more similar overall. The Amazonian species had some similarity with the other West Indian samples, potentially relating it to a common ancestor colonizing Central America and/or to a hybrid zone at the mouth of the Amazon River. Further statistical investigation of these loci, and the development of SNP panels, will be used to investigate evolutionary patterns and further inform speciation and hybridization potential, which could influence conservation listing decisions.

Effects of anthropogenic stressors on habitat use of bottlenose dolphins in Coastal Bend, Texas

Samantha Huron¹, Dara Orbach², Shawn McCracken³, William McGlaun⁴
¹Texas A&M University- Corpus Christi, Corpus Christi, Texas, ²Texas A&M University- Corpus Christi, Corpus Christi, Texas, ³Texas Sealife Center, Corpus Christi, Texas

Marine biota are increasingly exposed to multiple anthropogenic stressors including noise, pollution, shipping traffic, and habitat degradation. Anthropogenic disturbances have widespread direct and indirect consequences on marine life, particularly in coastal regions with high levels of industrialization. An imperiled population of bottlenose dolphins (Tursiops truncatus) resides in the South Texas Coastal Bend, an industrialized region undergoing extensive dredging in commercial ports and shipping channels. Photo-identification and geospatial data from 2014-2020 were integrated to determine if dolphins demonstrated a preference for areas with high risks of exposure to anthropogenic stressors. Boat surveys were conducted following transect lines in four regional bays. Dolphin dorsal fins were photographed to identify individuals based on their distinctive natural markings. GPS coordinates were recorded at the beginning of an encounter for each dolphin group sighted. Dolphin group observations, petrochemical production, and wastewater treatment plants within 50 km of each bay and recently dredged shipping pathways were mapped in ArcGIS Pro (ver. 10.7.1). Dolphins demonstrated habitat preferences, as over 90% of sightings occurred along the west side of Mustang Island and the south side of Harbor Island. While few group sightings occurred near wastewater treatment or petrochemical plants, many occurred along newly dredged channels. Dolphin sightings frequently overlapped with areas that will be dredged within 2021. Monitoring of identified preferred habitats is essential to better understand the impacts of dredging on dolphins and to mitigate potential harm to the population. As a bioindicator species, bottlenose dolphins can be used to infer the environmental quality and wellness of an
ecosystem and to help conserve diverse marine life.

The uncertain bioenergetics of North Atlantic right whales
Jasmin C Hütt¹, Peter Corkeron², Julie van der Hoop³, Michael J Moore⁴
¹GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany, ²New England Aquarium, Boston, Massachusetts, ³Department of Bioscience, Aarhus University, Aarhus C, Denmark, ⁴Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Critically endangered North Atlantic right whales (NARW) risk extinction, without substantive reduction of anthropogenic trauma. Decreasing population size is due to two main issues besides vessel collision: entanglement in fishing gear and changes in food availability due to ecosystem changes in the face of climate disruption. Both can affect NARW energetics, leading to reduced body condition, decreased reproductive success of individuals, and deterioration of overall population health. To measure the impact of these stressors and their interaction, energetic costs associated with entanglement and starvation were incorporated in a bioenergetic model, established for a generic female right whale. We compared models for a NARW living now, one from two decades ago, when the species’ abundance was increasing at approximately 2% year⁻¹, and a Southern right whale (SRW) from a population increasing at approximately 6% year⁻¹. Parameter uncertainty associated with daily estimates of food intake, basal metabolic rate, and possible influences of baleen rack disruption from entanglement were so great that differences between the three generic right whale females were indistinguishable. Further, it made robust predictions of NARW energy budgets – let alone the impact of specific stressors in varying intensity – impossible. Until these parameter uncertainties are addressed, the capacity of bioenergetic modeling to inform conservation management of NARW is too limited to be useful.

Stereotyped non-signature whistles are shared and exchanged between allied common bottlenose dolphin males (Tursiops truncatus) in Sarasota Bay, FL
Matthew Hyer¹, Laela Sayigh², Peter Tyack³, Vincent Janik⁴, Katherine McHugh⁵, Randall Wells⁵, Frants Havmand Jensen⁶
¹Middlebury College, Sudbury, MA, ²Woods Hole Oceanographic Institution/Hampshire College, Woods Hole, Massachusetts, ³University of St Andrews, St Andrews, ⁴University of St Andrews, St Andrews, Fife, United Kingdom, ⁵Chicago Zoological Society’s Sarasota Dolphin Research Program, Sarasota, Florida, ⁶Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Common bottlenose dolphins (Tursiops truncatus) in Sarasota Bay, Florida, live in a fission-fusion society where male pairs form tight social alliances, which may provide increased mating opportunities as well as benefits for feeding and protection. Extensive research has shown that bottlenose dolphins use individually distinct signature whistles to convey identity information and maintain and re-establish contact with conspecifics. Much less attention has been devoted to non-signature whistles, even though these whistles can make up a significant part of the repertoire of free-ranging animals. Here we investigate whether male alliances share non-signature whistles, and whether they are important for social interactions. During periodic health assessments, wild bottlenose dolphins were instrumented with sound and movement recording DTAGs before release. We analyzed 45.6 hours of tag data from 3 allied male pairs with both individuals tagged simultaneously. Stereo angle-of-arrival data and relative sound intensity were used to differentiate vocalizations from each tagged individual, and
whistles were visually classified into different call types based on their time-frequency contour. We found that all three male alliances produced stereotyped whistle contours that were different from their known signature whistles. Furthermore, alliance partners shared at least one stereotyped non-signature whistle type. One allied pair produced seven non-signature whistle types in both 2014 and 2017, three of which were shared. Shared non-signature whistles were commonly exchanged between alliance partners – out of 37 dyadic exchanges between partners, 22 included shared non-signature whistles. To investigate possible functions of these non-signature whistles, we linked sound production with observations of social interactions from visual focal-follows. Preliminary data suggest that signature whistles were used in a variety of social contexts, whereas stereotyped non-signature whistles were used predominantly leading up to social interactions. This suggests that shared non-signature whistles may be important either for alliance coordination or for mediating conspecific interactions.

Identification of dugong calls and feeding sounds using deep learning architecture
Kotaro Ichikawa1, Tomoya Yagi, Kotaro Tanaka, Chiaki Yamato, Kongkiat Kittiwattanawong, Nobuaki Arai
1Kyoto University, Kyoto, Kyoto, Japan, 2Kyoto University, 3Phuket, Thailand, 4Kyoto University, Kyoto, Japan

Passive acoustic monitoring has been used to study sounds produced by dugongs, *Dugong dugon*, which inhabit extremely shallow noisy environments in sub- to tropical coastal waters. Detection of dugong sounds, i.e. calls and feeding sounds, requires a robust detection performance throughout various conditions to facilitate the analysis of a huge dataset. Recently, deep learning architecture application for marine mammal sound detection has shown improved efficiency. We therefore applied the technique to identify dugong sounds. Dugong calls and feeding sounds were recorded off Talibong Island, Thailand. Custom made software were used to detect candidates of dugong calls and feeding sounds. Then correct and false detections were confirmed manually and labeled accordingly. We applied pre-processing by smoothing and signal enhancement for the tonal calls and broadband feeding sounds. Sonagrams of the dugong sounds were stored as images in tiff format. A total of 4871 calls and 4141 feeding sounds were used as training data and 2087 calls and 1774 feeding sounds as validation data in a transfer learning algorithm. We used Resnet50 as a base network to develop an identification model. Initial learn rate and number of epochs were 0.0003 and 10. F1 scores of the model for the calls and feeding sounds were 100% and 99.9%, respectively. Additionally, to test the robustness of the identification model, it was applied to a completely new dataset recorded in Talibong Island using different recorders and in different locations and years. A total image of 938 dugong calls and 2995 feedings sounds were successfully identified with F1 scores of 93.4% and 96.9%, respectively. This study had shown that deep learning architecture can promote passive acoustic monitoring of dugongs. The identification model can also be used as a pre-trained network to facilitate deep learning-based detection of tonal and broadband signals of other marine mammals.

Nutritional status and prey energy density govern reproductive success in a small cetacean
Lonneke IJsseldijk1, Sanne Hessing2, Amy Mairo3, Mariel ten Doeschate1, Jelle Treep4, Jan van den Broek3, Guido Keijl3, Ursula Siebert7, Hans Heesterbeek1, Andrea Gröne6, Maarten Frederik Leopold6
1Faculty of Veterinary Medicine, Utrecht University, Utrecht, Netherlands, 2Utrecht, Netherlands, 3Scottish Marine Animal Stranding Centre, 4Zoological Centre, Kralingse Plein, 5Medical Faculty, Utrecht University, 6Faculty of Veterinary Medicine, Utrecht University, Utrecht, Netherlands, 7Institute of Veterinary Medicine, University of Veterinary Medicine Hannover Foundation, Hannover, Germany

---

308
A variety of mammals suppress reproduction when they are in poor physical condition or when they experience environmental harshness. To date, in many marine mammal species, reproductive impairment has been correlated to polychlorinated biphenyls, the most frequently measured chemical pollutant. However, the relative importance of other factors such as resource quality remains to be studied. Therefore we investigated whether reproductively active females abandon investment in their foetus when conditions are poor, exemplified using an extensively studied cetacean species; the harbour porpoise (*Phocoena phocoena*). Data on disease, fat and muscle mass and diet obtained from necropsies in The Netherlands were used as proxies of health and nutritional status and related to pregnancy and foetal growth. We then combined this with published pregnancy rates for sixteen other study areas across the distributional range of the harbour porpoise to correlate to mean energy density of prey constituting diets (MEDD). We found that mature female nutritional status had a significant effect on foetal size and that females in poor health status had lower probabilities of being pregnant and generally did not sustain pregnancy throughout gestation. Pregnancy rates from the different areas across the Northern Hemisphere were strongly correlated with MEDD, with pregnancy rates generally higher in areas where porpoises were feeding on prey with higher mean energy densities. These findings demonstrate the importance of having undisturbed access to prey with high energy densities in determining reproductive success and ultimately population size.

Both prey encounters and spatial memory influence Area Restricted Search behaviour in harbour seals

Virginia Iorio-Merlo¹, Isla Graham², Rebecca Clare Hewitt¹, Geert Aarts³, Enrico Pirotta⁴, Gordon Hastie⁵, Paul M. Thompson¹

¹University of Aberdeen, Cromarty, United Kingdom, ²University of Aberdeen, Cromarty, Ross-Shire, United Kingdom, ³WMR, Den Helder, Netherlands, ⁴University of St Andrews, St Andrews, Scotland, United Kingdom, ⁵Sea Mammal Research Unit, St Andrews

Predators are expected to initiate Area Restricted Search (ARS) upon the encounter of a prey item, thereby increasing the probability of finding additional prey and maximising foraging efficiency. However, predators targeting large and cryptic prey species are often faced with large stochasticity in prey encounters and may also rely on memory to target previously visited foraging patches before initiating ARS. It is unknown how predators combine knowledge of their environment and recent experience to adjust these fine-scale movements. In this study, we first used GPS-GSM movement data from 31 harbour seals tagged in NE Scotland to quantify individual repeatability of foraging patch use. Secondly, we used archival dive and accelerometry data from a sub-set of individuals to estimate the influence of spatial memory and prey encounters on ARS behaviour. Specifically, we used tracking data to build memory maps of previously searched areas, and accelerometry data to detect prey catch attempts. Using a Hidden Markov Model, we showed that both the time spent previously searching in an area and prey catch attempts increased the probability of initiating ARS. These results are consistent with ARS theory, but also provide evidence that these
predators rely on memory to focus searching behaviour.

**Respiration cycle duration and seawater flux through open blowholes of humpback (Megaptera novaeangliae) and North Atlantic right (Eubalaena glacialis) whales**

Maria Clara Iruzun Martins¹, Carolyn Miller², Philip Hamilton³, Jooke Robbins⁴, Daniel Zitterbart⁵, Michael J Moore²

¹Sea Mammal Research Unit, University of St Andrews, London, United Kingdom, ²Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, ³Anderson Cabot Center for Ocean Life, Boston, Massachusetts, ⁴Center for Coastal Studies, Provincetown, Massachusetts, ⁵Woods Hole Oceanographic Institution, Woods Hole, MA

Little is known about the dynamics of baleen whale respiratory cycles, especially the mechanics and activity of the blowholes and their interaction with seawater. In this study, the duration of complete respiration cycles (expiration/inhalation events) were quantified for the first time in two species: North Atlantic right whale (NARW) and humpback whale (HW) using high resolution, detailed imagery from an unoccupied aerial system (UAS). The mean duration of complete respiration cycles (expiration/inhalation event) in the NARW and HW were 3.07 s (SD = 0.503, n = 15) and 2.85 s (SD = 0.581, n = 21), respectively. Furthermore, we saw no significant differences in respiration cycle duration between age and sex classes in the NARW, but significant differences were observed between age classes in the HW. The observation of seawater covering an open blowhole was also quantified, with NARW having 20% of all breaths with seawater presence versus 90% in HW. Seawater incursion has not been described previously and challenges the general consensus that water does not enter the respiratory tract in baleen whales. Prevalent seawater has implications for the analysis and interpretation of exhaled respiratory vapor/mucosa samples, as well as for the potential inhalation of oil in spills.

**A novel model to predict whale feeding behavior from satellite-linked tags**

Ladd Irvine¹, Daniel M. Palacios¹

¹Oregon State University, Newport, Oregon

Fitting movement models to satellite tracking data is often used to study ecosystem- and basin-scale movements and habitat use of marine mammals. Latent processes affecting horizontal movement can be explored within these frameworks and are used to infer underlying behavioral states such as “transiting” and “area-restricted searching” (ARS), with ARS often presumed to represent foraging. However, these behavioral state estimates are not based on a direct link to feeding, potentially confounding the interpretation of such models. Recent advances in bio-logging technologies have incorporated sensors to monitor dive and feeding behavior into long-duration (weeks to months) Argos-linked tags for large whales. However, a direct measure of feeding has not been implemented into these models to explicitly link observed movement to the underlying diving behavior which drives it. We expanded existing hierarchical Bayesian movement models to estimate a latent “foraging state” at each location.
using tag-measured feeding data (lunges per dive) which occurred during the corresponding time interval. Performance of different model formulations was assessed using both simulated and empirical time series of whale feeding behavior lasting multiple weeks. In both cases, a continuous record of known (from archival tags) and simulated whale feeding behavior was subsampled to replicate the irregular nature of feeding behavior summaries transmitted by Argos. Model predictions of foraging state generated from the subsampled data were compared to corresponding continuous time series to determine how well the underlying known trend of feeding behavior was recovered. This new foraging state model is a significant development in our ability to examine the spatial and temporal characteristics of large whale feeding behavior at regional- and ecosystem- scales. It links a proximal driver of occurrence and habitat use (diving behavior associated with feeding) to horizontal movement behavior and informs how well movement-based measures of behavior can represent feeding at different scales.

**Historical Review of Shark Predation on Live Stranded Pinnipeds Admitted to The Marine Mammal Center, 2010-2020.**

Jackie Isbell¹, Padraig Duignan², Barbie Halaska¹, Maggie Martinez³, Mariah Tengler³, Shelbi Stoudt¹

¹The Marine Mammal Center, Sausalito, CA, ²The Marine Mammal Center, Sausalito, California, ³The Marine Mammal Center

Sharks are common predators to several pinniped species commonly found along the central California coast. Great white sharks (GWS, Carcharodon carcharias) are the principal predators of pinnipeds in this range and, due to their seasonal migration, exhibit a peak presence along the North Pacific coast from August to September. Shark trauma is seen regularly in patients admitted to The Marine Mammal Center (TMMC), which include California sea lions (Zalophus californianus), pacific harbor seals (Phoca vitulina), northern elephant seals (Mirounga angustirostris), and northern fur seals (Callorhinus ursinus). Predated pinnipeds often present with obvious gross external lesions such as jagged-edged and roughly parallel lacerations and/or variably sized crescentic triangular skin perforations or scars. The lesions vary from acute to chronic and may be either the primary reason for rescue or an incidental finding. We reviewed pinniped admission records from 2010-2020 to examine annual trends and patterns in shark predation trauma across the TMMC range in central California from Mendocino to San Barbara counties. Parameters such as pinniped species, age class, anatomic trauma location, and strand date were compared. We identified a total of 233 confirmed cases in 4 pinniped species, including 198 California sea lions, 18 pacific harbor seals, 15 northern elephant seals, and 2 northern fur seals, with a peak in admitted cases observed in the fall (August through October). California sea lions were the primary species admitted with shark predation trauma, making up 85% of confirmed cases. Of California sea lions admitted over the same period, 3% were shark predation victims that primarily stranded in Monterey and San Luis Obispo counties. Our observed trends support previous studies of seasonality in shark predation consistent with the GWS migration.

**Cetacean distribution and species diversity along south eastern coast and marine water of Bangladesh.**

Mohammad Islam, Cetacean Research & Conservation Program (CRCP), Marinelife Alliance, Bangladesh, Bangladesh

Bangladesh south east coastal and marine water is very important habitat for marine cetacean species. During the last twenty years monitoring of live, stranding and washed ashore individual’s Marinelife Alliance recorded 10 species of odontoceti and mysteceti. These included
Bryde’s whale (*Balaenoptera edeni*), pygmy sperm whale (*Kogia breviceps*), Risso’s dolphin (*Grampus griseus*), indopacific humpback dolphin (*Sousa chinensis*), Indo-Pacific finless porpoise (*Neophocaena phocaenoides*), spinner dolphin (*Stenella longirostris*), Irrawaddy Dolphin (*Orcaella brevirostris*), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*). The continental self extends from 80 kms to 200 kms at various location of the country coast. The closest oceanic zone depth provides suitable habitat or the large baleen whale is swatch of no ground (SONG) and underwater canyon that runs through the Continental Self to Oceanic zone at the south central to south western coast of Bangladesh. The Irrawaddy dolphins are regularly spotted along the coast and rivers viz., Naf river, Reju Canal, Moheshkali channel, Kuheliacanal, Ujanita. Humback dolphins recorded along the coast at various locations. Other smaller odontoceti’s recorded at nearshore to offshore areas. All of the species facing similar threats from habitat fragmentations through the fishing gears deployment, at sea and also cross netting on small rivers and canals. In some areas along river mouth and estuaries coastal set bag net is a huge concern particularly at Balkkhali river and Naf river mouth. Small dolphin movement has been drastically reduced during the last 20 years along the whole area. The habitat disturbances due to mass tourism from the local people is evident that has been witnessed during the 2020 covid lockdown along the coast of Cox Bazar the tourism capital of Bangladesh, dolphins were swimming along the coast very close the beach while there was no people on the territory. Recent washed shore baleen whale might be of victims of ship strike at oceanic zone would be a major conservation issue of large whales in Bangladesh.

Using an omnidirectional video logger to observe the underwater life of marine animals: Humpback whale resting behaviour

**Takashi Iwata¹**, Erik Martin Biuw², Kagari Aoki³, Patrick Miller⁴, Katsufumi Sato⁵ ¹Kobe University, Kobe, Japan, ²Institute of Marine Research, ³Atmosphere and Ocean Research Institute The University of Tokyo, Chiba, Japan, ⁴Sea Mammal Research Unit, School of Biology, University of St Andrews, St Andrews, Fife, United Kingdom

Animal-borne video loggers are powerful tools for investigating animal behaviour because they directly record immediate and extended peripheral animal activities; however, typical video loggers capture only a limited area on one side of an animal being monitored owing to their narrow field of view. Here, we investigated the resting behaviour of humpback whales using an animal-borne omnidirectional video camera combined with a behavioural data logger. In the video logger footage, two non-tagged resting individuals, which did not spread their flippers or move their flukes, were observed above a tagged animal, representing an apparent bout of group resting. During the video logger recording, the swim speed was relatively slow (0.75 m/s), and the tagged animal made only a few strokes of very low amplitude during drift diving. We report the drift dives as resting behaviour specific to baleen whales similar to what has been observed with seals, sperm whales and loggerhead turtles. Overall, our study shows that an omnidirectional video logger is a valuable tool for interpreting animal ecology with improved accuracy owing to its ability to record a wide field of view.
Evaluation of pygmy and dwarf sperm whale (Kogia sp.) strandings along the east coast of Florida (2002-2019)

Teresa Jablonski1, Wendy Noke-Durden1, Megan Stolen2, David Rotstein3, Sarah Rodgers4, Tatiana Ferrer5, Greg O’Corry-Crowe6, Judith St. Leger7

1Hubbs-Sea World Research Institute, Melbourne Beach, FL, 2Blue World Res. Inst., Melbourne Beach, FL, 3Marine Mammal Pathology Services, Olney, Maryland, 4Indian River State College, 5FAU-HBOI, Fort Pierce, FL, 6Florida Atlantic University, 7Sea World San Diego, San Diego, CA

While pygmy (Kogia breviceps) and dwarf sperm whale (Kogia sima) strandings are relatively common along the southeastern United States, the elusive species remains understudied throughout much of its range. Long-term, systematic stranding response is a powerful tool to better understand the biology of the species, investigate stock structure, and to evaluate mortality trends. Kogia sp. stranding events along the east coast of Florida (2002-2019; n = 67 cases) were reviewed including 51 pygmy sperm whales and 16 dwarf sperm whales. The majority of Kogia strandings were male (n = 42) followed by 21 females (two pregnant), and 4 animals of unknown sex. Forty-four whales stranded alive and five stranding events involved mother-calf pairs. Stranding events did not significantly differ by season ($X^2 = 3.746, df = 3, p = 0.2902$). Gross findings and histopathological analyses were systematically evaluated (n = 37). Animals ranged in size from 84 cm to 355 cm and 72% were sexually mature. For cases in which a significant cause of stranding was determined, 57% of events were related to heart disease (cardiomyopathy). Animals frequently presented in poor nutritional condition (54%) and 63% of animals presented gastric parasites. Marine debris was present in the digestive tract in 7% of cases, all involving plastic ingestion. Genetic analyses were conducted on both species (n = 31), including custom designing primers for studies of mtDNA variation, and successfully establishing a new aDNA approach to extract DNA from teeth. The aDNA approach revealed substantial levels of mtDNA variation in K. breviceps and holds promise in assessing Kogia sp. when fresh tissue is not available. This study provides a systematic review of Kogia strandings along the east coast of Florida as well comprehensive health and mortality findings that are needed for this elusive species.

Evidence of a permanent calf exchange between three North Atlantic right whale mothers while in the Southeast U.S. calving area

Katie Jackson1, Jennifer Jakush2, Philip Hamilton1, Kelsey Howe3, Brenna Frasier4, Timothy R. Frasier5, Clay George6, Melanie White7, Lisa Conger8

1Florida Fish and Wildlife Conservation Commission, St Petersburg, FL, 2Florida Fish & Wildlife Conservation Commission, Jacksonville, Florida, 3Anderson Cabot Center for Ocean Life, Boston, Massachusetts, 4Anderson Cabot Center for Ocean Life at the New England Aquarium, Somerville, MA, 5Saint Mary's University, Hubley, Nova Scotia, 6Saint Mary's University, Halifax, Nova Scotia, 7Georgia Department of Natural Resources, Brunswick, GA, 8Granite State Whale Watch, Rye, NH, 9Northeast Fisheries Science Center, Woods Hole, MA

The coastal waters of the Southeast U.S. (SEUS) are the primary calving area for endangered North Atlantic right whales (Eubalaena glacialis). Calf production has been monitored each winter by systematic aerial surveys since 1994 and biopsy sampling since the 2000s and the photo-identification and genetic data are maintained in two long-term collaborative databases. Here we describe the discovery and timeline of a calf exchange involving three right whale mothers (Eg3115, Eg3440, and Eg3860) during the 2015-2016 calving season. Eg3115 was first sighted with her white-bellied,
biological calf on December 10, 2015, and Eg3440 was first sighted with her black-bellied, biological calf on December 22. Eg3860 was never sighted with a biological calf, but was able to nurse her adopted calf, so we presume that she lost a calf or fetus around the time of the exchange. After January 11, Eg3115 was sighted with the calf of Eg3440, Eg3440 was without a calf, and Eg3860 was with the calf of Eg3115. The calves of Eg3115 and Eg3440 were a minimum age of 17-32 days and 5-20 days, respectively, when the exchange occurred between December 27 and January 11. All five whales were biopsy sampled – the calves post-exchange – and our observations were confirmed genetically. These associations continued throughout 2016 in spring and summer feeding areas, including the Gulf of St. Lawrence – a feeding area with a high-rate of inter-annual return, mortality, and entanglement since 2015. There is limited information about adoption in cetaceans, especially baleen whales, but a reciprocal calf exchange was detected via genetic analyses once before in the North Atlantic right whale population in 1997. Although rare and likely accidental, these occurrences raise questions about cow-calf bonding and other aspects of reproductive behavior, which could have important monitoring implications given the population’s low reproductive rate and anthropogenic

The peripheral lymphatic system provides a route for fluid transport throughout the body, supporting vital homeostatic functions including removal of metabolic waste and excess fluid, and immune surveillance. The recently discovered brain lymphatic system (i.e., glymphatic system) is the analog of the lymphatic system in the brain and has shown to play a key role in CNS health by driving clearance of wastes, modulating brain immune response, and distributing important compounds throughout the brain. Vasculature in the brain differs from the periphery in that it is entirely ensheathed by glial end feet, creating a unique compartment called the perivascular space. The donut-shaped perivascular space is a tunnel surrounding the vasculature that creates a pathway for the transport of CSF into the brain and serves as the primary neuroimmune interface between the blood and neural tissues. Glymphatic flow is directly affected by changes in cerebral blood flow, intracranial pressure, and noradrenergic tone, highlighting the interplay between the vasculature and perivascular space in glymphatic function. Glymphatic system clearance is also suppressed during states of low oxygen. Therefore, the brain lymphatic system of marine mammals, who routinely experience hypoxia during breath-holds, may be susceptible to alterations in glymphatic function. Our goal was to provide preliminary data on the perivascular space morphology in a marine mammal. We utilized detailed gross and histological examination of brain tissues to better understand the function of the glymphatic system in *Tursiops truncatus*. Preliminary results reveal a prominent perivascular space surrounding the vasculature and highlight the potential dynamic interplay between the vasculature and perivascular space that could play a vital role in glymphatic clearance. Expanding our knowledge of the glymphatic system morphology of mammalian divers is critical to the evaluation of pathobiology and could lead to new strategies to improve marine mammal CNS health.

First report of brain lymphatic structures in a marine mammal (*Tursiops truncatus*): Implications for central nervous system (CNS) function, injuries, and diseases

*Olivia Jackson*¹, Tiffany Keenan², William McLellan³, D. Ann Pabst⁴, Sentiel Rommel⁵, Michael Tift⁵

¹University of North Carolina Wilmington, Leland, NC, ²UNC Wilmington, Wilmington, NC, ³University of North Carolina Wilmington, Wilmington, NC, ⁴University of North Carolina, Wilmington, NC, ⁵University of North Carolina, Wilmington, North Carolina
Blowfield Sampling of Small Toothed Whales with Unmanned Autonomous Aircraft
Jamey Jacob1, Jason Bruck2, Aaron Alexander3, Rick Gaeta3, Brooke Jacob3, Kerrick Ray3, Arvind Santhanakrishnan1
1Oklahoma State University, Stillwater, OK, 2Stephen F. Austin State University, Nacogdoches, Texas, 3Oklahoma State University

As unmanned aerial vehicles (UAVs), aka drones, increase in popularity as a tool for monitoring and studying cetaceans a number of limitations have come to light with respect to current platforms. This includes but is not limited to harassment risk, behavioural alteration of subjects and difficulty with obtaining blow samples using rotary UAVs that deflect analyzable materials because of wind shear near the water. We present the development of a novel platform designed to mitigate these limitations through the use of acoustic and visual stealth advancements specifically built around the sensory capabilities and blow physics of small toothed whales. Blow-field modelling using both simulations through computational fluid dynamics and experimental laboratory based analogues using high-speed particle image velocimetry data granted a better estimation of successful blow collections as part of the development process. We will highlight device development, capability, advantages and operation of the platform including preliminary data collection opportunities. We will also preview new imagining technology and the implications for AI guided flight and approach to autonomously track populations and identify candidates for sample collection.

Environmental drivers and spatial covariation in baleen whale seasonal abundance: Implications for the Dungeness Crab Fishery in California
Nadav Nur1, R. Cotton Rockwood2, Julie Howar3, Jaime Jahncke1
1Point Blue Conservation Science, Santa Rosa, CA, 2Point Blue Conservation Science, 3Point Blue Conservation Science, Petaluma, CA

The number of whales entangled in fishing gear along the West Coast of the United States has increased sevenfold in recent years compared to the long-term average from 1990 to 2013, resulting in a conflict between fishing and protections for whales. Increased understanding of seasonal changes in the spatial occurrence and patterns of large whales will allow agencies to take management actions to reduce impacts to both whales and to the Dungeness crab fishery. To that end, we compiled and analyzed multiple time series of surveys of humpback (Megaptera novaeangliae) and blue (Balaenoptera musculus) whales, spanning the coast from North-central California to the Channel Islands, for the period 2003-2019. Time series included surveys at the Farallon Islands, Monterey Bay Whale Watch, surveys of whales from boats transiting to/from the Channel Islands, the ACCESS Project in north-central California and whale surveys during NOAA rockfish cruises. We found that environmental conditions predicted well arrival and departure dates at or near the Farallon Islands for both species, during migration to and from breeding areas, as was the case in Monterey Bay, and at the Channel Islands. Monthly indices of upwelling predicted arrival and departure, yielding model with high predictive value (adjusted R-squared exceeding 0.75). In addition, the habitat compression index, which tracks the area of coastal upwelling habitat, predicted well departure of whales from the Gulf of the Farallones. Furthermore, monthly patterns of abundance at the Farallon Islands were predicted by changes in abundance 1 or 2 months previously at Monterey Bay, while monthly patterns of abundance in Monterey Bay were predicted by shifts in abundance from the Farallones, as well as to the Channel Islands. Our results provide a strong, statistical basis for the use of predictive models to guide opening and closing dates for the Dungeness Crab Fishery in
Not all those who wander are lost. Recent North Atlantic right whale (Eubalaena glacialis) sightings in the Gulf of Mexico

Jennifer Jakush1, Katie Jackson2, Tom Pitchford2, Monica Zani1, Kelsey Stone1, Melanie White1, Blair Mase-Guthrie6
1Florida Fish & Wildlife Conservation Commission, Jacksonville, Florida, 2Florida Fish and Wildlife Conservation Commission, St Petersburg, FL, 3Anderson Cabot Center at the New England Aquarium, Boston, MA, 4Florida Fish and Wildlife Conservation Commission, St. Petersburg, Florida, 5Granite State Whale Watch, Rye, NH, 6NOAA/NMFS/SEFSC, Miami, FL

North Atlantic right whales (Eubalaena glacialis) typically occur in the western North Atlantic. Sightings in the Gulf of Mexico (GOM) are very rare. Little is known about right whales in this habitat, and it is unclear if sightings represent wandering individuals, remnant use of historical habitat, or range expansion. Aerial surveys are conducted each winter along the Atlantic coast of the southeastern U.S., the species’ primary calving grounds, to monitor reproduction and habitat use, and to mitigate anthropogenic effects (e.g. vessel-strikes). Recent public sightings in the GOM, well beyond established management areas and monitoring efforts, presented several challenges. From December 2017 - March 2018, there were 14 public sightings of a lone right whale along the west coast of Florida. The temporal extent of these sightings was notably longer than previous GOM events, raising questions about prolonged use of this habitat and concern for exposure to threats in this area (e.g. vessel traffic, dense fixed fishing gear). Individual identification is a primary objective of right whale monitoring efforts and documentation gathered from public observations eventually lead to identification of the whale as a yearling, Eg4715. In March 2020, researchers confirmed 14 public sightings of a right whale mother (Eg3560) and her dependent calf between Pensacola and the Florida Keys. Prior to 2020, there was no evidence to suggest how right whales might navigate the shallow waters and heavily used seascape of Florida’s middle and lower Keys. During both recent events, researchers utilized information from public sighting reports and social media to better understand travel patterns, identify the individual whales and assess their health status, inform response efforts, and target conservation actions. Monitoring the extralimital movements of this endangered species is important as right whale distribution has shifted in recent years and prevention of anthropogenic injury and mortality is critical.

Sexing cetaceans typically requires extended periods of observation or expensive molecular methods. An alternative approach using photo-identification may provide a cost-effective, noninvasive method for assigning a sex to free-ranging individuals. We investigated two methods for predicting the sex of common bottlenose dolphins (Tursiops truncatus) from Namibia, using the rate of change in dorsal fin a) trailing edge marks or b) surface features (scarring and lesions) and binary logistic regression models. Our results suggest animals with frequent and extensive changes to dorsal edge marks, or a high number/proportion of the
dorsal fin covered in surface features are likely male, while those with little to no changes in dorsal edge marks or low numbers/proportion of surface features are likely female. Both sex prediction models performed reasonably well (accuracy: edge marks: 100%, surface features: 83%), with a high degree of consensus between models in sex predictions (78.6%). Our models are straightforward to implement and robust for the study population, providing useful insights into individuals’ sex and population demographics. This reliable, inexpensive, and minimally invasive framework for assigning sex could be widely applicable, if population-specific information of known sex individuals is included, due to the variable social systems and behaviors exhibited by Tursiops sp.

The short-term effect of dolphin watching boat on Into-Pacific bottlenose dolphins in Jeju Island, Republic of Korea

Soojin Jang¹, Mi Yeon Kim², Dong-Guk Paeng³, Jae Chun Choe⁴

¹Ewha Womans University, South Korea, ²Marine Animal Research and Conservation, ³Department of Ocean System Engineering, Jeju National University, Jeju-si, Jeju Special Self-Governing Province, South Korea, ⁴Ewha Womans University, Seoul, South Korea

Marine mammal-watching tourism has developed worldwide over the past decades, and small dolphins that habituate coastal areas are most frequently exposed. In Jeju Island, the Republic of Korea, boat-based dolphin-watching tourism has recently been introduced to the Indo-Pacific bottlenose dolphins. The encounter rates of boats and dolphins remain 80% in a particular area, and the number of dolphin-watching companies is increasing. This study aimed to investigate the short-term effect of dolphin-watching boats on behaviors and activity patterns of the Indo-Pacific bottlenose dolphin. From March 2019 to August 2020, boat-dolphin encounters were studied in the Deajeong area, the southwest coast of Jeju Island. We observed the types and duration of dolphins' behavior according to the presence or absence of tour boats and the approach distance. Dolphins' use of the coastal areas and the shift in the group composition were also collected.

As the tour boat approached, activity budgets for foraging decreased, and traveling and socializing increased to the tour boat presence. Markov chain analysis revealed that dolphins were less likely to stay foraging in the presence of tour boats and were more likely to begin traveling. Although the distance from the shore used by dolphins did not significantly change, the tour boat's movement trapped the dolphins between the coast and the boat itself. The group cohesion was also found to be significantly disturbed. The tour boat presence increased dolphins’ tendency to act individually, dispersing the group or not forming a cohesive group by scattering over the area. These behavioral responses are likely to have energetic costs for individuals, resulting in population-level impacts. Currently, there are no specific regulations regarding Jeju dolphin tourism. Dolphin-watching regulations are urgently needed to minimize potential long-term impacts on this small and distinct population.

Biomarkers of brevetoxin exposure in lymphoblast cells

Jordan Jobson¹, Eman Taher¹, Mayra Tabares¹, Pawlos Tsegay², Yuan Liu², Kathleen Rein¹

¹Florida International University, Miami, Florida, ²Florida International UNiversity, Miami, FL

The Florida red tide organism, Karenia brevis, produces a suite of toxins known as the brevetoxins. These toxins are responsible for massive fish kills and marine wildlife poisonings. A pervasive red tide bloom beginning in late 2017 off the southwestern coast of Florida and lasting nearly two years, resulted in 177 confirmed manatee deaths in 2018, and a combined total of 380 confirmed or suspected
red tide-related deaths during the two-year time span. Brevetoxin exposure in rescued marine animals can be confirmed by analysis of stomach contents. However, there are few reliable biomarkers of exposure. Exposure to the Florida red tide dinoflagellate *Karenia brevis*, has been linked to oxidative stress in marine life. Our studies with the most abundant of the brevetoxins, PbTx-2 have established that PbTx-2 increases the expression of the inflammatory cytokine IL-8, and the reduced GSH content in lymphoblast cells. Both are associated with oxidative stress. Redox proteomics and metabolomics were carried out on lymphoblast cells treated with PbTx-2 and compared to control cells. Differences in metabolites, gene expression and cellular redox status were observed. We shall further examine the ability of antioxidants to alleviate the brevetoxin induced oxidative stress. These findings may be used to develop a biomarker profile for brevetoxin exposure in marine animals and could lead to a mechanism-based treatment for exposure to brevetoxins.

**Dramatic Shifts in Hawaiian Monk Seal Pupping Dates, and Implications for Understanding Current and Future Population Trends**

*Thea Johanos¹, Stacie Robinson², Albert Harting³, Michelle Barbieri⁴*

¹Hawaiian Monk Seal Research Program, Honolulu, HI, ²NOAA, ³Harting Biological Consulting, Bozeman, MT, ⁴NOAA National Marine Fisheries Service, waialua, hi

Timing of reproductive events is an important indicator of population health and recovery potential. Although Hawaiian monk seals (*Neomonachus schauinslandi*) pup asynchronously, the majority of pupping occurs during spring and summer. Because mean inter-birth interval is greater than a year, females that pup in consecutive seasons gave birth later the following year. Our study investigates whether pupping dates differ over time or by region, and how observed differences might relate to current and future population trends and environmental factors. We examined 2,528 pupping records from survey data across the Hawaiian archipelago from 1981 to 2021. Currently, mean pupping date differs by up to 30 days between locations, ranging from 17 May in the main Hawaiian Islands (MHI) to 11 June at French Frigate Shoals (FFS) in the Northwestern Hawaiian Islands (NWHI). There is no consistent geographic gradient in pupping dates across the Hawaiian Archipelago. Instead, the variation likely has more to do with age structure; with younger females giving birth early in the season and older, successful females pupping later and later. Using linear regression, we found a pattern of progressively later pupping at NWHI sites (slope 0.925, *p* < 0.0001), with pupping dates occurring 17 to 37 d. later than in the 1980s. Differences in pupping dates were not detected in the recently reestablished main Hawaiian Island subpopulation (slope -1.121, *p* =0.264). At FFS, where pupping is most delayed, there was a pulse of well populated cohorts in the 1980s-90s which then advanced to older ages, and the mean age of mature females has risen from 13.4 in 1998 to 17.6 years in 2021. These findings suggest that shifts in pupping dates may indicate underlying changes in age structures within subpopulations across the NWHI.

**Conservation Energetics of beluga whales (Delphinapterus leucas): Measuring resting and diving metabolism to understand threats to an endangered population**

*Jason John¹, Dennis Christen², Katherine Flammer³, Traci Kendall¹, Beau Richter¹, Verena Gill⁴, Terrie Williams⁵*

¹University of California Santa Cruz, ²Georgia Aquarium, Atlanta, Georgia, ³Georgia Aquarium, Atlanta, GA, ⁴NOAA Fisheries, Anchorage, Alaska, ⁵University of California Santa Cruz, Santa Cruz, California
Energy use and acquisition represent a critical balance that is essential for survival in wild animals. In marine mammals such as beluga whales (*Delphinapterus leucas*) understanding this balance can provide insight into how these species interact with the environment around them and respond to threats or disturbances. The first step in developing bioenergetic models to examine these interactions requires an examination of resting and active energetic demands. We used open-flow respirometry to measure oxygen consumption during rest and submerged swimming in beluga whales and compared these measurements with a commonly studied odontocete, Atlantic bottlenose dolphins (*Tursiops truncatus*). Both resting metabolic rate (RMR, 3012 ± 126.0 kJ·hr⁻¹) and total cost of transport (COTTOT, 1.4 ± 0.1 J·kg⁻¹·m⁻¹) in beluga whales were consistent with predicted values for similarly sized marine mammals in cold environments, including the bottlenose dolphins measured in this study. Using the measured RMR and submerged locomotor costs, we calculated the field metabolic rate and surface swimming costs of beluga whales. By coupling the rate of oxygen consumption ($V_{O2,dive}$) during submerged swimming with locomotor metrics, we developed predictive relationships for assessing energetic costs from accelerometers deployed on beluga whales. Significant relationships between $V_{O2,dive}$ and swim speed, stroke rate ($f_s$), and partial dynamic acceleration in the X and Y axes combined were identified. Combining these data with our calculated aerobic dive limit for beluga whales (8.8 min) we find that high-speed responses to disturbance will markedly reduce the species’ diving capacity, pushing the cetaceans to costly anaerobic performance that requires prolonged recovery periods. Overall, this study provides conservation managers with critical data needed to quantify energy expenditure and concomitant resource demands of beluga whales and to predict the impact of disturbance on the total energy budget.

Using ocean gliders to characterize baleen whale habitat in the Northwest Atlantic

**Hansen Johnson¹**, Kimberley Davies², Mark Baumgartner³, Christopher Taggart⁴

¹Dalhousie University, ²University of New Brunswick, Saint John, New Brunswick, ³Biology department, Woods Hole Oceanographic Institute, Woods Hole, MA, ⁴Department of Oceanography, Dalhousie University, Halifax, Nova Scotia

The availability and abundance of low trophic-level baleen whale prey is coupled, to varying degrees, to oceanographic processes. Therefore, the distribution of baleen whales in a feeding habitat should also be linked to variation in those processes. Assessment of these linkages is challenging because of the difficulty in obtaining sufficient spatially and temporally concurrent in situ observations of the whales and local oceanographic conditions. We collected a multi-year series of concurrent acoustic whale detections and high-resolution oceanographic measurements from Slocum ocean gliders to evaluate how baleen whales associate with and partition their feeding habitat. The focal habitat was Roseway Basin, a relatively small (30x60 km), shallow (<180 m) basin on the Scotian Shelf located ~40 km seaward of SW Nova Scotia. Data were collected from 16 fall (September – November) glider surveys of the Basin over a six-year period (2014 – 2020). Gliders were equipped to collect high resolution full-depth profiles of salinity, temperature, and depth as well as audio to detect and classify whale sounds. A suite of oceanographic variables was derived each day (n = 629) and paired with daily acoustic presence of right (n = 78), fin (n = 403), sei (n = 148), and humpback (n = 100) whales. Several multivariate methods, including linear discriminant function analysis, were used to evaluate how each species associated with and partitioned the oceanographic habitat. Preliminary analyses indicate that fin whale detections were nearly ubiquitous, more likely
related to their long-range acoustic detectability than to favorable habitat. In contrast, right, sei, and humpback whales were associated with different oceanographic conditions. Right whales, for example, occurred more often in well-stratified water columns overlying high-density bottom waters, consistent with conditions previously demonstrated to have a role in aggregating their copepod prey at depth in shelf basins.

Using Computer-Based Models to Assist With Photo-Identification of Florida Manatees (Trichechus manatus latirostris)

Jennifer Johnson¹, Nathaniel Wagner², Rosa Gradilla², Kerri Scolardi³, Sheri Barton⁴, Christina Nau³¹Mote Marine Laboratory, Sarasota, ²New College of Florida, ³Mote Marine Laboratory, Sarasota, Florida, ⁴Mote Marine Laboratory, Sarasota, FL

Photo-identification is a mark-recapture technique widely used for identifying and tracking many types of species. Florida manatees can be identified through unique scars and/or mutilations acquired on an individual’s trunk or fluke. Mote Marine Laboratory has been gathering photo-identification data on manatees for over 30 years, which has resulted in a collection of over 488,000 images of distinctive individuals, supporting a catalog of over 10,000 IDs. Photo-identification studies require the continuous collection and processing of images, part of which entails trained researchers manually searching through hundreds to thousands of representative images to identify matches to cataloged animals. This process has become increasingly time-consuming and labor-intensive as more data are collected and new individuals are added to the catalog. As technology in data sciences has advanced, numerous areas of scientific research have benefited from using computer-based models and techniques to improve the efficiency of processing large data sets. In July 2020, Mote Marine Laboratory and graduate students from New College of Florida began collaborating on the creation of an automated matching program, with the goal of reducing the time and effort required in the searching process. The initial approach was to model scar similarity with a Siamese neural network and triplet loss function; however, this proved to be unsuccessful with the given data, as the model failed to find similarities. The current process uses composite sketches of each manatee’s “features” (scars and/or mutilations) and involves isolating the features via contour extraction by computing the external contour of each feature and collecting details such as length, width, orientation, and aspect ratio. To aid with location of the feature(s), an application was developed for a user defined bounding box to narrow down the region(s) of interest. Results are promising thus far, but significant improvements are still needed to enhance the model’s matching ability.

Analysis of a Rough-Toothed Dolphin (Steno bredanensis) Introduction in a Human Care Setting

Lindsey Johnson¹, Megan Broadway², Michelle Schisa³, Heidi Lyn⁴¹University of Southern Mississippi, ²University of Louisiana at Monroe, Monroe, Louisiana, ³Gulf World Marine Park, Panama City Beach, Florida, ⁴University of South Alabama, Ocean Springs, Mississippi

Rough-toothed dolphins are a rarely studied species of cetaceans found in temperate and tropical waters throughout the world. These dolphins live in fission-fusion societies and are highly social, swimming in tightly-packed and highly synchronized subgroups consisting of 2–10 individuals. The current study documents the introduction of a stranded calf into an existing population of six rough-toothed dolphins living in a human care setting. Specifically, recordings of vocal and non-vocal behaviors were analyzed
across the four phases of the study: baseline, day of introduction, post-introduction, and follow-up. Whistles, a vocal signal associated with social contexts, increased from baseline to post-introduction phases (after an initial drop on the day of introduction) for both the new dolphin and the resident group. Non-vocal social behaviors showed the same pattern. Finally, whistle production was associated with social behaviors when considering all of the phases, but the association only held for the baseline condition when the relationship was assessed within each phase. This research helps to build knowledge about how this little-known species navigates the formation of new relationships and may inform procedures for future dolphin introductions.

Investigating Site Fidelity and Seasonal Abundance of an Expanding Harbor Seal Population in the Mid-Atlantic

Danielle Jones, US Navy, Virginia Beach, Virginia

Harbor seal (Phoca vitulina) distribution along the U.S. east coast has expanded to the mid-Atlantic. Until 2018, NOAA Stock Assessment Reports indicated that the southern extent of the Western North Atlantic stock was New Jersey; with scattered sightings and strandings reported as far south as Florida. Since 2014, the U.S. Navy has investigated seal presence in the coastal waters of Virginia, which are important areas for Navy training and testing activities. Haul-out counts, photo-identification, and tagging efforts have been utilized to acquire a better understanding of seal occurrence, habitat use, and haul-out patterns in the region; and the first seasonal harbor seal abundance estimates were produced for the area. From 2014-2020, harbor seals were observed returning seasonally to haul-out locations in Virginia in the fall, and remaining in the area until spring. From the photo-identification analysis, 121 harbor seals were identified, of which 75 were observed once and 46 were re-sighted both within a season and across multiple seasons, indicating some degree of seasonal site fidelity in coastal Virginia. For some individuals, re-sightings have spanned 36 to 47 months. To estimate the local population abundance of harbor seals, mark-recapture data from the photo-identification portion of the study was used to fit a Lincoln-Peterson model. We also experimented with using a correction factor for the count data that was based on telemetry data on harbor seal activity in Virginia waters. Abundance estimates calculated from the Lincoln-Peterson model and the telemetry correction factor approach ranged from 81 (95% CI: 44.14-117.19) to 242 (95% CI: 91.35-392.65) and 143 (95% CI: 0-388.05) to 226 (95% CI: 52.67-398.35) individual harbor seals, respectively. The results from this study will allow the Navy to limit interactions with these protected species, design better mitigation measures where interactions are unavoidable, and maintain environmental compliance.

Developing Machine Learning Tools to Predict The Health Status of Navy Bottlenose Dolphins From Whistle Recordings

Brittany Jones1, Jeremy Karnowski2, Jessica Sportelli3, Sam Ridgway4


Recently, there have been incredible strides in applying deep learning methods to predict the presence of diseases in humans (e.g., Parkinson’s, depression, Covid-19) from voice. One recent study successfully applied this technique to animal welfare, predicting the presence of disease in chickens from their vocalizations. These deep learning algorithms work by using vocalizations as input, transforming those inputs through a series of layers composed of artificial 'neurons' (which progressively learn more complex audio features)
to produce a classification output. Deep learning typically identifies complex patterns that may not be obvious to human analysts. The US Navy Marine Mammal Program in San Diego, CA maintains an extensive health history database for each animal as part of a preventive medicine program. Additionally, researchers record the Navy dolphins’ acoustic behavior during periods of time they spend in above-ground pools as part of their normal mobility training. A substantial vocal catalog is maintained for each focal dolphin and can be leveraged for machine learning applications. Together, these result in a unique, labeled dataset comprised of whistles (input) emitted during differing health conditions (label) that are utilized for training deep learning models. We present pilot results detailing the current success of the models at predicting health information from a subsample of our acoustic data. Further, we describe the applied goals of the project for the continued development and eventual application as a veterinary tool for the early prediction of changes in the health status of dolphins.

Comparative Cardiorespiratory Patterns in Pinnipeds

Ryan Jones¹, Colleen Reichmuth², Nicole Thometz², Madeline Meranda³, Todd Schmitt⁴
¹UC Santa Cruz, Santa Cruz, CA, ²University of California Santa Cruz and Alaska SeaLife Center, Santa Cruz, California, ³University of San Francisco, San Francisco, CA, ⁴University of California, Santa Cruz, ⁵SeaWorld San Diego, San Diego, CA

When submerged, mammals exhibit a dive response to conserve precious oxygen stores. This physiological condition is characterized by cessation of breathing (apnea), decrease in heart rate (bradycardia), and reduced blood flow to the extremities (peripheral vasoconstriction). As amphibious mammals, pinnipeds are adapted for terrestrial and marine living. However, most of what is known about the cardiorespiratory behavior of pinnipeds has been carried out on actively diving individuals. Further, the majority of available data have been collected with only a few, well-studied species. Here, we explore cardiorespiratory patterns in phocids, otariids, and odobenids resting out of water to evaluate how these patterns differ as a function of evolutionary biology or life history traits. Replicate data sets (n > 15) were obtained from harbor, ringed, spotted, bearded, and Hawaiian monk seals, California and Steller sea lions, [NT1] and walruses (n = 20 individuals). Individuals were conditioned to position calmly on a conductive surface for > 5 minutes during electrocardiogram measurements, while corresponding spontaneous respirations were recorded to video. All subjects displayed a clear bimodal distribution of heart rate between bradycardic and tachycardic states. Bradycardia was linked to periods of apnea, regardless of apnea duration. Prior work suggests that all pinnipeds “dive” while at rest on land by punctuating extended breath holds with bouts of clustered respiratory events. While each subject in our study exhibited some degree of this apneustic breathing pattern, notable differences were apparent. Some species breathed more regularly and others more intermittently while at rest, driving predictable changes in heart rate. Preliminary [NT2] analyses highlight species- and family-level differences in typical apnea duration, respiratory rate, and absolute and dynamic range of instantaneous heart rate between tachycardia and bradycardia. These data provide an initial comparative framework with which to consider evolutionary adaptations for diving as well as physiological trends related to phylogenetic relationships.

Visual observation of synchronous feeding behavior by mother and calf humpback whale (Megaptera novaeangliae) by UAV in the Bay of Fundy, Canada

Toby Stephenson¹, Lindsey Jones², Ann Zoidis³, Sean Todd⁴
Humpback whales, as rorquals, entrap large aggregations of prey and water within an expandable throat pouch, then expel water from the mouth through baleen plates in a foraging behavior described as “gulp feeding”. In a development of this technique, humpbacks often make a final lunge towards fast moving prey, overtaking, and engulfing them. Lunge feeding has been observed on all feeding grounds, although how this behavior is acquired is unclear, due to a lack of visual documentation of mother-calf synchronous lunge feeding. Here we describe a first description, captured through unmanned aerial vehicle (UAV) footage, of a calf synchronously mimicking its mother lunge feeding in the northern Gulf of Maine. During field research operations in 2021, in the Bay of Fundy, Canada, we observed a humpback mother and calf exhibiting gulp feeding in a synchronized manner and obtained video of the event using a Phantom 4 drone. Prey sampling was not conducted concurrently but based on video imagery and common humpback prey sources in the Bay of Fundy, the food source was likely a patch of krill (*Meganyctiphanes norvegica*). Video demonstrates the mother approaching a patch of prey from below at an oblique angle, left side up. As the mother lunges and the throat pouch expands just below the surface, the calf is seen swimming ventrally to the mother in a similar aspect and direction, but at a slower speed, opening its mouth in a gulping fashion, and then gulping a second time toward the surface as the mother completes her foraging sequence. The calf’s foraging event is slightly delayed from the mother’s by 2-3 seconds, mimicking and perhaps benefiting from the mother’s lunge. Our visual observation adds to a more nuanced understanding of essential and observable ontogeny in whales as they acquire foraging skills.

A Real-Time Data Assimilative Forecasting System for Animal Tracking.
Marine Randon¹, Michael Dowd², Ruth Joy³
¹Simon Fraser University, Burnaby, British Columbia, ²Department of Mathematics and Statistics, Dalhousie University, Halifax, Nova Scotia, ³Simon Fraser University

Monitoring technologies can now provide real-time animal location information which opens the possibility of forecasting systems to fuse these data with movement models to predict future animal trajectories. State space modelling approaches are established for retrospective location estimation and behavioral inference through state and parameter estimation. Here, we use a state space model as the basis for a comprehensive data assimilative framework for probabilistic marine mammal movement forecasting. Real-time location information is combined with stochastic movement model predictions to provide forecasts of future animal locations and trajectories. Implementation uses ensemble-based sequential Monte Carlo methods. As a demonstration, we adapt and apply this framework to a visual sighting observation track of the endangered Southern Resident Killer Whale. A continuous-time stochastic movement model is used based on an Orstein-Uhlenbeck process that includes a time-varying persistence parameter estimated through state augmentation. Potential functions set the drift term to allow movement to reflect historical habitat utilization. We estimate whale locations up to 2.5 hours in advance with a moderate prediction error (< 5.5 nm), providing reasonable lead-in time to mitigate vessel strike risk. This forecasting system can use diverse data types, improve animal movement models, and has the potential to become an important new direction for movement ecology.
The role of sea ice in shaping habitat use, phenology, and reproductive variability of eastern North Pacific gray whales (Eschrichtius robustus)

Trevor Joyce1, Megan Ferguson2, Catherine Berchok3, Dana Wright1, Jessica Crance4, Eric Braen5, Joshua Stewart1, Tomo Eguchi6, Wayne Perryman7, David Weller8

1Environmental Assessment Services, Inc. affiliated with NOAA Southwest Fisheries Science Center, La Jolla, CA, 2Alaska Fisheries Science Center/NOAA, Seattle, WA, 3Marine Mammal Laboratory, Seattle, WA, 4Duke University Marine Laboratory, Beaufort, NC, 5Marine Mammal Laboratory, NOAA Alaska Fisheries Science Center, 6University of Washington, Cooperative Institute for Climate, Ocean, and Ecosystem Studies, 7NOAA SWFSC Marine Mammal & Turtle Division, San Diego, 8Marine Mammal and Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, La Jolla, CA, 9National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center, La Jolla, California, 10Southwest Fisheries Science Center, NOAA, San Diego, California

High variability in annual estimates of eastern North Pacific gray whale (Eschrichtius robustus) calf production have shown a strong negative relationship with Pacific Arctic sea ice cover (r = -0.6) over recent decades. This correlation has led to a hypothesis that extensive late-spring/early-summer ice may exclude reproductive females from early season access to important benthic foraging hotspots during an energetically demanding phase of gestation associated with accelerated fetal growth. Here, we examine whether patterns of gray whale distribution and phenology in the Pacific Arctic align with this sea ice exclusion hypothesis, particularly in light of two recent outlier events (2013-14 and 2017-19) that have deviated from historical patterns of reproductive correlation with ice cover. Overall, a nonlinear and strongly negative relationship was found between gray whale aerial counts and sea ice cover (GAM, p < 0.001), with steepest negative slope above 45-50% sea ice concentration. Extensive aerial survey effort (641,461 km) recorded a small number of gray whale observations at local sea ice concentration values up to 90-95%. However, these rare sightings at high sea ice concentrations generally occurred along the periphery of larger masses of sea ice and no gray whales were sighted > 7 km inside the 40% sea ice concentration contour. Comparisons of early season distribution patterns further revealed that gray whale sightings were absent in several key foraging hotspots during years with delayed ice break-up but were present in these habitats in years of early-to-average ice retreat. Overall, in situ aerial and acoustic observations were consistent with the sea ice exclusion hypothesis, indicating the ability of gray whales to penetrate dense sea ice over limited distances but also suggesting challenges in moving through larger masses of sea ice. These results have important implications for gray whale population dynamics in a rapidly changing Arctic environment.

Quantifying microplastic ingestion by rorqual whales with high-resolution field measurements

Shirel Kahane-Rapport1, Max Czapanskiy2, James Fahlbusch3, Ari Friedlaender4, Jeremy Goldbogen5, Matthew Savoca6

1Hopkins Marine Station, Stanford University, Pacific Grove, CA, 2Hopkins Marine Station, Stanford University, Pacific Grove, CA, 3Stanford University, Cascadia Research Collective, Pacific Grove, CA, 4University of California Santa Cruz, Santa Cruz, California, 5Stanford University, Pacific Grove, CA, 6Hopkins Marine Station, Stanford University, Monterey, CA

Microplastic pollution is a ubiquitous anthropogenic stressor in the world’s oceans. Microplastics are synthetic polymers <5mm and often much smaller (~100µm). There is limited
quantitative information on the degree and severity of microplastic ingestion for marine mammals, some of which may be at high risk due to their distributions, habitat preferences, and feeding modalities. Microplastic ingestion has only recently been confirmed in baleen whales, but they are presumed to be highly susceptible to microplastic ingestion due to their filter-feeding behavior, prey preferences, and habitat overlap with heavily polluted areas. Rorqual whales (Balaenopteridae) feed via lunge-filtration and are likely to ingest plastic that has previously been consumed by their prey, but unlike other predatory species, they may also ingest plastic directly from the water column during filter feeding.

By combining high-resolution behavioral data for blue, fin, and humpback whales, from DTAG, CATS tag, and medium duration tag deployments, and published information on plastic pollution in the California Current System, we generate a high-resolution quantitative estimate of potential plastic ingestion by baleen whales. We determined what proportion of all plastic ingested was likely to come from trophic transfer (primary ingestion) versus filtered directly from the water column (secondary ingestion) using a Monte Carlo simulation.

In our most likely scenario, blue whales ingest a median of $1.09 \times 10^7$, fin whales ingest $5.73 \times 10^6$, krill-feeding humpbacks ingest $3.86 \times 10^6$, and fish-feeding humpbacks ingest $1.96 \times 10^5$ pieces of plastic per day. We estimate that whales consume considerable levels of plastic through both primary and secondary ingestion, but trophic transfer via prey consumption contributes most to total plastic ingestion. Larger rorquals ingest more plastic in both absolute and mass-specific terms. Our findings allow us to better clarify the potential for bioaccumulation of plastic-associated contaminants and provide a quantitative estimate of microplastic consumption that can be tested with additional field data.

Factors Affecting Harem Size and Structure in Northern Elephant Seals (Mirounga angustirostris)

Ellie Kaiser¹, Melissa P Voisinet², Kate Riordan³, Emma Weitzner⁴, Cameron Cooper⁵, Paige Edwards⁶, Heather Liwanag⁷

¹California Polytechnic State University, Bozeman, MT, ²California Polytechnic State University San Luis Obispo, ³California Polytechnic State University - San Luis Obispo, San Luis Obispo, CA, ⁴California Polytechnic State University, ⁵Clovis, California, ⁶California Polytechnic State University, San Luis Obispo, California

Northern elephant seals (NES, Mirounga angustirostris) have a highly polygynous breeding system in which harems of reproductively receptive females are dominated by a single alpha-ranking male. NES are an ideal system for polygynous breeding research because reproduction occurs on visually unobstructed beaches, where breeding behaviors can be easily observed. We examined factors impacting NES harem size (number of females per harem), structure (number of subordinate males present), and density (number of seals per unit area), as well as the dynamics of these harem features, throughout the 2019 and 2020 breeding seasons at the Piedras Blancas rookery (San Simeon, CA). We hypothesized that the position of a harem relative to others (central, peripheral, isolated) would be a significant predictor of harem size, with central harems expected to be the largest. We also predicted larger harems would include more subordinate (beta- and charlie-ranking) males than smaller harems, and that beach size would significantly influence harem size and density. We found harem size was dependent on position, with central harems being the largest and isolated harems the smallest. Our multiple regression model indicated that harem size was positively
correlated with both harem density and the number of charlie-ranking males (i.e., non-breeding, subadult males). Additionally, harem position was found to modify the relationship between harem size and the number of charlie-ranking males present in a harem. Harem size and structure varied significantly over the course of the breeding season, with harem size declining precipitously after the majority of weaning had occurred. Harem size was positively correlated with beach size, whereas harem density was negatively correlated with beach size, with larger beaches having lower density. This is the first study to systematically examine the factors affecting harem size and structure in NES, and the results are likely applicable to other highly polygynous species.

Reducing uncertainty in position and received levels of simulated sonar to improve understanding of response by Cuvier’s beaked whales (Ziphius cavirostris) off Cape Hatteras, North Carolina

Nick Kaney1, Amy Bu1, Larry Chen1, William Cioffi2, Camaren Dayton2, Heather Foley3, John Joseph4, Tetyana Margolina5, Jennifer Schultz6, Zachary Swaim7, Nathan Yu7, Larry Zheng7, Brandon Southall8, Robert Schick7


Deep-diving beaked whales are known to respond to naval sonar. Increasing our understanding of the behavioral response of beaked whales is critical to guide future policies to effectively manage and mitigate negative effects of military training. To do so, we used ancillary data to refine positional estimates of individually satellite-tagged whales at the surface and in the water column, in turn improving estimates of received levels (RLs). As part of the Atlantic Behavioral Response Study, 16 satellite-transmitting position and depth tags were deployed on Cuvier's beaked whales in the spring.
and summer of 2019. The tag’s pressure sensor recorded depth every 5 minutes for ~2 weeks. The duration of all but one tag overlapped with at least one of four controlled exposure experiments (CEEs), where target RLs were up to 140 dB re 1µPa. We augmented the positional data returned from the ARGOS system with information on individual tags from focal follow vessels equipped with goniometers. This positional data was included as input to an Ornstein-Uhlenbeck movement model to generate 100 estimates of position at each 5-minute interval during a CEE. These estimates, along with the depth data, were coregistered with output from a sound propagation model to estimate RL in the water column. During a 30-minute CEE in August, 2019, the focal animal (ZcTag095) received an estimated RL of 133.8 dB re 1µPa (121.0 - 144.25 dB re 1µPa, 95% CI). We found that including ancillary information substantially reduced uncertainty in positional estimates and RL estimates. Here we document a process to better estimate RLs while taking advantage of the long duration of satellite-tags, which can be used in subsequent dose response modeling. Narrowing uncertainty, both in terms of distance and RL, is critical to better understanding and developing predictive functions of different responses.

The Phenology of Humpback (Megaptera novaeangliae), Blue (Balaenoptera musculus), Fin (Balaenoptera physalus), Sperm (Physeter macrocephalus), and Killer Whales (Orcinus orca) Determined by Passive Acoustic Monitoring Near Barkley Canyon
Karianne Kapfer1, Athena Rycyk2, K. S. Jasper Kanes3

1Cornell University, Ithaca, NY, 2New College of Florida, Sarasota, Florida, 3Ocean Networks Canada, Victoria, BC

Cetaceans are often found far offshore and require continuous observation, making them difficult to study using traditional methods. To combat these difficulties, we used a passive acoustic monitoring dataset from a bottom-mounted (average depth: 391.67 m) hydrophone deployed by Ocean Networks Canada near Barkley Canyon off the West Coast of Vancouver Island, Canada, to determine when various cetacean species were present based on the detection of their vocalizations. The main call types detected were tonal calls from humpback whales (Megaptera novaeangliae), B calls from blue whales (Balaenoptera musculus), 20 Hz calls from fin whales (Balaenoptera physalus), and pulsed calls from killer whales (Orcinus orca). Humpback whales were heard year-round with a peak vocal presence in December. Blue whales were heard in February and from September-December, with a peak presence in October. Fin whales were heard from January-May and August-December, with a peak presence in January. In 2013, killer whales were heard from May-August with a peak presence in August. While in 2014, they were present from January-April, in July, September, and December with a peak presence in September. Sperm whales (Physeter macrocephalus) were heard from February-October with a peak presence in May. They were also found to vocalize most often between 00:00-13:00. We discuss factors that may influence the seasonal patterns in presence for each species, such as seasonal migration, peaks in productivity or prey movement, and the differences between each stock/ecotype. Understanding when cetaceans species are present near Barkley Canyon aids conservation efforts by identifying habitats that are important and adds to our understanding of these species.

Linking Spatial Distributions of Whales and their Euphausiid Prey Within the Northern California Current Ecosystem
Rachel Kaplan1, Kim Bernard2, Solene Derville3, Dawn Barlow4, Jennifer Fisher5, Kym Jacobson6, Leigh Torres6

1Oregon State University, 2College of Earth,
Spatial distribution patterns of marine predators are non-random within the ocean’s patchy prey landscape, and they are often highly correlated with distribution of their targeted prey. Three rorqual species (blue, fin, and humpback whales) forage within the Northern California Current ecosystem (NCC) off the west coast of the United States, but little is known about their seasonal habitat use patterns. Baleen whales primarily target two different species of krill: *Euphausia pacifica* and *Thysanoessa spinifera*. We hypothesize that they discriminate between krill species and reproductive stages when foraging, and that their preferences are evident through correlations in the distribution patterns of these predators and prey. Furthermore, we hypothesize that the whales preferentially target the energetically rich species *T. spinifera*, and gravid krill of both species. During six research cruises between 2018 and 2020 (224 hours of marine mammal survey effort) we synoptically recorded baleen whale sightings through systematic distance sampling and collected active acoustic data (Simrad EK60 and EK80) to assess their zooplankton prey. Krill swarm characteristics and metrics (e.g. swarm intensity and frequency of occurrence) were assessed relative to the estimated density of each baleen whale species using Generalized Additive Models. Preliminary results indicate that including metrics of krill swarm intensity and frequency moderately improves GAM results, and that foraging whales may target relatively small, shallow swarms. Further analysis will investigate the rorqual species-specific spatial relationships with krill subgroups in order to refine our understanding of predator-prey ecology. This study highlights the importance of understanding prey distribution and quality to enable a deeper understanding of baleen whale foraging ecology and distribution patterns. In light of concerns over whale entanglement issues in the NCC region, these results could inform management efforts to mitigate entanglement risk.

How do harbour seals (Phoca vitulina) modulate their behaviour in response to tidal currents?

**William Kay**, James Bull, Rory Wilson, Ursula Siebert, Tom Stringell, Luca Borger

1Swansea University, Cwmbran, Torfaen, United Kingdom, 2Swansea University, Swansea, United Kingdom, 3Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Buesum, Schleswig-Holstein, Germany, 4Bangor, United Kingdom, 5Swansea University, Swansea, United Kingdom

Quantifying the environmental drivers of variation in the movement and behaviour of wild animals is essential for informing their management. For marine megafauna, an understanding of how they use tidal currents is limited, yet this information is crucial for determining the potential impact of new anthropogenic threats associated with these hydrodynamic features, such as tidal stream turbines (TSTs). Here, I use a hidden Markov modelling framework to analyse the movement and behavioural responses of harbour seals (*Phoca vitulina*) to tidal currents using high-frequency GPS and dive data collected on 24 individuals from three sites in a tidal stream environment (TSE) in the North Sea. Results showed that rather than modulate their movements within behavioural states, seals instead switched behavioural strategies altogether in response to current conditions and the
occurrence of tail-currents was key in modulating this. While behavioural state persistence was generally high (~ 80 %), tidal-currents increased the probability for seals to switch between behavioural states by approximately 30 %. Seals preferentially foraged in tail- as opposed to head-current conditions. No clear differences arose between sites and sexes, though juvenile responses were more acute than for adults, suggesting the former are more susceptible to currents, likely owing to their reduced movement capacity. The HMM framework indicated that 3 sets of discrete-valued random-effects (“behavioural contexts”) were required to account for individual-variation, or for variability driven by missing covariates. In the context of related research, my results suggest that depth-usage and diet are key factors that need to be further investigated to fully elucidate the use of tidal currents by harbour seals. The findings here have clear implications for the TST industry as they suggest that seals in these areas target tail-currents for foraging, putting them at risk from collision with operational devices.

Mining an Underutilized Marine Mammal-collected Oceanographic Dataset to Further Understanding of the Biologically Critical Coastal Southern Ocean

Theresa Keates1, Mike Goebel1, Clive McMahon1, Mark Hindell1, Christophe Guinet4, Luis A. Hückstädt6

1University of California Santa Cruz, 2NOAA - Fisheries, 3Sydney Institute of Marine Science, Mosman, NSW, Australia, 4University of Tasmania, Hobart, Tasmania, 5Centre d’Etudes Biologiques de Chizé (CEBC), Chize, France, 6Institute of Marine Sciences, University of California Santa Cruz, Santa Cruz, California, United Kingdom

Sustained physical and biological observations are crucial to understanding, predicting, and mitigating the effects of anthropogenic stressors on marine mammal habitat in a rapidly changing ocean. A variety of oceanographic variables are routinely measured by a large array of sampling platforms from Argo floats to satellites, but additional sampling methods and platforms are needed to better meet global ocean observing needs and enhance our understanding of physically driven ecological processes. This is especially true in regions difficult to sample using these more traditional techniques. Deploying tracking tags on marine mammals offers a valuable supplement to more traditional ocean observing methods, providing data from remote regions at relatively low cost. The emerging collaboration introduced here assesses the feasibility of using existing but previously underutilized datasets collected by marine mammals (water column temperature and light penetration data) to describe oceanographic variability in data-deficient coastal areas of the Southern Ocean. We focus on these data not yet evaluated for their oceanographic relevance in the Southern Shetland Islands and the Kerguelen Plateau collected by Antarctic fur seals (Arctocephalus gazella), Weddell seals (Leptonychotes weddellii), and Southern elephant seals (Mirounga leonina). Quality assessment and oceanographic analyses of these data will determine their utility to illustrate biologically relevant environmental parameters such as mixed layer depth, fresh (melt) water intrusions, and light penetration (euphotic layer), among others. These oceanographic parameters strongly influence the nearshore prey field available to Antarctic marine mammals and other predators. The results have the transformative potential to establish new methods to unlock stores of unexplored information derived from datasets originally collected for other purposes and filling gaps in our knowledge of Southern Ocean surface and coastal oceanography and ecology. These understudied and dynamic coastal regions are areas of sustained biological production and are thus of elevated ecological relevance.
Bubble-net Tool use in Humpback whales (Megaptera novaeangliae) foraging off the Irish coast.
Emer Keaveney¹, Davide Michel Lelong², Andy Rogan³, Michelle E.H. Fournet⁴
¹Ocean Research & Conservation Association of Ireland, Ireland, ²Gropello Cairoli, Pavia, Italy, ³Ocean Alliance, Gloucester, MA, ⁴Sound Science Research Collective

Bubble-net feeding is a complex foraging strategy used by different populations of humpback whales, documented in Massachusetts, South-East Alaska, Northern British Columbia, Australia, and Antarctica. A group of humpback whales or a solitary individual expels air underwater to form a vertical cylinder-ring, stream, or cloud of bubbles to corral and stun small schooling prey species, such as herring and sprat. Here we quantitatively document what the public and whale watching operators have anecdotally reported in Irish waters. We analysed the structure of bubble-netting behaviour of an individual whale off the south coast of Ireland with examples of confirmed bubble-netting behaviour in two other populations known to engage in this behaviour. In doing so, we demonstrate behavioural similarity between allopatric populations and confirm shared foraging techniques among individuals that lack geographic overlap.

Fin whales of the Great Bear Rainforest: Balaenoptera physalus vellera in a Canadian Pacific fjord system
Eric Keen¹, James Pilkington², Eadin O'Mahony³, Kim-Ly Thompson³, Benjamin Hendricks⁴, Nicole Robinson⁴, Archie Dundas⁵, Linda M. Nichol⁵, Hussein Alidina⁶, Hermann Meuter⁷, Chris Picard⁷, Janie Wray⁸
¹Scripps Institution of Oceanography, La Jolla, California, ²Fisheries and Oceans Canada, Nanaimo, BC, ³University of St Andrews, Cork, Ireland, ⁴SoundSpace Analytics, Cumberland, BC, ⁵Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, British Columbia, ⁶Victoria, ⁷Hartley Bay, ⁸North Coast Cetacean Society, Qualicum Beach, British Columbia

Fin whales are widely considered an offshore and oceanic species, but certain populations also use coastal areas and semi-enclosed seas. Based upon fifteen years of study, we report the return of Canadian Pacific fin whales to the Kitimat Fjord System (KFS) in the Great Bear Rainforest, and the establishment of a seasonally resident population in its intracoastal waters. This is the only fjord system along this coast or elsewhere in which fin whales are known to occur regularly with strong site fidelity. The KFS was also the only Canadian Pacific fjord system in which fin whales were commonly found and killed during commercial whaling (Gregr and Trites 2000), pointing to its long-term importance. Traditional knowledge, whaling records, and citizen science databases depict the extirpation of fin whales from this area, as well as their absence in the years prior to their return in 2005-2006. Visual surveys and mark-recapture analysis document their repopulation of the area, with 100 – 120 whales now using the fjord system in recent years, as well as the establishment of a seasonally resident population with rates of annual return now higher than 70%. Line transect surveys identify the central and outer channels of the KFS as the primary fin whale habitat, with the highest densities occurring in Squally Channel and Caamaño Sound. Fin whales have been observed in the KFS in most months of the year. Vessel- and shore-based surveys (27,311 km and 6,572 hours of effort, respectively) indicate regular fin whale presence (2,542 detections), including mother-calf pairs, from June to October and peak abundance in late August – early September. Seasonal patterns are variable year-to-year, and several lines of evidence indicate that fin whales arrive and depart from the KFS repeatedly throughout the summer and fall. Additionally, we report on the population’s social network and
Emerging Themes in Population Consequences of Disturbance Models
Kelly Keen¹, Roxanne Beltran², Enrico Pirotta³, Daniel Costa⁴
¹University of California, Santa Cruz, ²University of California Santa Cruz, Felton, CA, ³University of St Andrews, St Andrews, Scotland, United Kingdom, ⁴Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA

Assessing the population-level effects of disturbance from human activities is critical for conserving and managing marine mammal populations. However, linking short-term responses to long-term impacts on individuals and populations has remained a significant hurdle for managers, practitioners, and industry when evaluating the risks of a proposed activity. The Population Consequences of Disturbance framework conceptually links disturbance to population dynamics, and its real-world application has led to a suite of mathematical models to forecast the possible consequences of disturbance. In isolation, these species- and context-specific models are limited in their applicability across taxa and disturbance scenarios; however, when considered holistically, can provide valuable insight into which contextual factors influence a population’s magnitude of exposure and sensitivity to disturbance, including species for which data are limited and models are unavailable. We review 32 models for more than 15 cetacean and pinniped species exposed to one or more disturbance sources including general sources (44% of models), environmental change (25%), offshore wind farms (16%), vessel traffic (16%), commercial fishing (13%), ecotourism (9%), seismic surveys (6%), sonar (6%), and epizootic events (3%). In so doing, we identify common themes and highlight general principles to consider when assessing risk. We find that exposure likelihood and disturbance sensitivity relate strongly to a population’s life-history traits, with resident populations, income breeders, and small-bodied individuals (juveniles and young, mature females) and species being most vulnerable to disturbance. We also find that limiting or avoiding exposure to repeated or continuous disturbance in biologically important habitats and during periods of reproductive sensitivity and low prey availability may reduce the potential for population-level effects. These emerging themes can help wildlife managers and practitioners identify and prioritize the populations most vulnerable to disturbance and guide industry in planning activities that avoid or mitigate population-level effects.

Total mercury concentration in Steller sea lion femurs
Mary Keenan¹, Nicole Misarti², Lara Horstmann³, Lorrie Rea⁴, Julie Avery¹
¹University of Alaska Fairbanks, Fairbanks, Alaska, ²University of Alaska Fairbanks, Water and Environmental Research Center, Fairbanks, Alaska, ³University of Alaska Fairbanks, College of Fisheries and Ocean Sciences, Fairbanks, Alaska, ⁴University of Alaska Fairbanks, Fairbanks, Alaska

Mercury (Hg) is an environmental contaminant that is toxic in high amounts, but can also have sublethal effects that impact population dynamics. Bone is a resilient biological material with compartments that have different Hg turnover rates. Previous studies suggest a difference in total mercury concentration [THg] in spongy bone (recent Hg prior to death) compared with compact bone (Hg over lifetime). However, it is unknown whether [THg] varies along (proximal, central, distal) a single long bone. Steller sea lions (SSL, Eumetopias jubatus) are an ideal species for this research, because they are long-lived (bioaccumulation) and occupy high trophic levels (biomagnification). We hypothesized that adult femur [THg] varies along compact and spongy bone, but not along bone shaft, while pup femurs would be...
homogenous in [THg]. This helps us understand Hg heterogeneity in marine mammal bone and identify a consistent sampling location for the future. Five pup and one adult femur(s) were macerated in nanopure water to remove muscle and cartilage. [THg] was quantified with a Nippon MA-3000 (Nippon Instruments Corporation, Tokyo). [THg] in individuals’ spongy bone ranged from 20ppb-475ppb and compact bone ranged from 13ppb-34ppb. After averaging all individuals the [THg] varied along the bone from 105ppb proximal transition, 96ppb proximal spongy, 32ppb center cortical, 125ppb center spongy, 84ppb distal spongy, and 117ppb distal transition. Using repeated measures ANOVA, we found no significant difference in [THg] along bone in pup and adult femurs (p=0.967); however, we did find a significant difference among individuals (p<0.01). We found no significant difference (p=0.356) between compact and spongy bone in pups (as expected), nor in the adult, potentially due to unintentional burns during the bone cutting process. Future research will examine variation in [THg] along bones of SSL in different age categories including juveniles, sub-adults, and adults.

A gross and histologic description of the circumvallate gustatory papillae and taste buds of four odontocete species

Tiffany Keenan1, William McLellan2, Sentiel Rommel1, Alex Costidis3, 'Hans' J.G.M. Thewissen1, Takushi Kishida5, David Rotstein6, D. Ann Pabst7
1UNC Wilmington, Wilmington, NC, 2University of North Carolina Wilmington, Wilmington, NC, 3Virginia Aquarium and Marine Science Center, 4Northeast Ohio Medical University, Rootstown Township, OH, 5Wildlife Research Center, Kyoto University, Kyoto, Kyoto, Japan, 6Marine Mammal Pathology Services, Olney, Maryland, 7University of North Carolina, Wilmington, NC

Gustatory chemoreception is not fully understood in odontocete cetaceans. Genomic studies suggest a loss of function for all except salty taste receptors, while behavioral studies of Tursiops truncatus demonstrate discriminatory taste and marked food preferences. Morphological studies have provided evidence both for and against the existence of taste receptors. No study to date, though, has systematically surveyed across the oral cavity and lingual surfaces of multiple odontocete species to describe the presence or absence of gustatory papillae and taste buds. We used standard histological and immunohistochemical techniques to investigate the oral epithelium of four odontocete species (T. truncatus, Stenella frontalis, Delphinus delphis, Kogia breviceps) with the goal of identifying and describing the anatomy and distribution of taste papillae and buds. We report our preliminary results for circumvallate papillae, which are highly conserved sensory structures across vertebrates. Circumvallate papillae were observed on the caudodorsal tongue of all species, although they varied in number and morphology across species and ontogeny. Delphinids were found to possess a single, continuous, V-shaped row of 3-9 papillae, whereas K. breviceps possess two longitudinal rows comprised of 2-4 papillae each. The number of circumvallate papillae were reduced in adults, as compared to juveniles, of all species examined. Taste buds were found on dorsal and lateral surfaces of these papillae, distributed in areas of relatively thin epithelium. Innervation was concentrated in the lamina propria at the interface of the dermal-epidermal junction deep to tastebuds. The ducts of well-developed mucoserous salivary glands emptied onto the surface epithelium of, and into the trench surrounding, the circumvallate papillae, suggesting that taste buds may be flushed with saliva containing food particles or chemical stimuli to enhance perception. These preliminary results demonstrate that multiple odontocete species possess sensory structures associated with gustation in other vertebrates.
Resighting Histories of Dart-Attached Tags in Cuvier’s Beaked Whales (Ziphius cavirostris) and Fin Whales (Balaenoptera physalus) in the Eastern Pacific Ocean.
Erin Keene1, Erin Falcone2, Gregory Schorr3, Brenda Rone1, Gustavo Cárdenas Hinojosa4, Russel Andrews5
1Marine Ecology & Telemetry Research, Seabeck, WA, 2Marine Ecology and Telemetry Research, Seabeck, Washington, 3Marine Ecology & Telemetry Research, Seabeck, Washington, 4Comision Nacional de Areas Naturales Protegidas, Ensenada, Baja California, Mexico, 5Marine Ecology and Telemetry Research, Kingston, WA

Dart-attached tags deployed on cetaceans have provided valuable behavioral data for extended periods, but their potential negative impacts should be monitored. We used photographs to evaluate healing in previously-tagged Cuvier’s beaked whales (Ziphius cavirostris, Zc, n=46) from Southern California (SoCal, n=36) and Guadalupe Island (GI, n=10), and fin whales (Balaenoptera physalus, Bp, n=71) along the U.S. West Coast, 2008-2019. Of these, 25 Zc (n=16, 44% from SoCal; n=9, 90% from GI) and 27 Bp (38%) were resighted at least one day post-deployment. Whales were resighted up to 59 different days over periods up to 3,697 days, both with and without the tag attached. Lasting effects appeared minimal for both species, and ranged from undetectable to superficial scars, including small dorsal fin nicks or holes. To date, no tagged individuals have been resighted with swellings, depressions or abscesses at or near the attachment site. One whale was tagged twice: SoCal Zc ID132 was tagged in 2014 with a 2-dart Low Impact Minimally-Invasive Percutaneous Electronic Transmitter (LIMPET tag) and again with a 4-dart Type A archival tag in 2018. The LIMPET resulted in two small tag site scars when re-evaluated at 1,539 days, which persisted through all subsequent resightings. The archival tag resulted in similar small attachment scars as well as additional shallow linear scrapes at 552 days post-deployment. SoCal Zc ID42, the first Zc tagged in the study in 2008, was resighted in 2012 with a single dart shaft protruding from the tag site, which otherwise appeared normal (no swelling or visible exudate around the dart). However, when it was resighted again in 2016 and 2018, only small superficial scars were visible at the attachment site, similar to whales without obvious residual dart pieces post-detachment. These observations suggest that lasting impacts of these tags are likely minimal, as intended.

Seasonal abundance and distribution of pinnipeds in a protected island in southern Brazil
Aline Kellermann1, Daniela Martins Machado Oliveira2
1Chico Mendes Institute for Biodiversity Conservation (ICMBio), Wildlife Refuge Ilha dos Lobos, Torres, Rio Grande do Sul, Brazil, 2ICMBio, Wildlife Refuge Ilha dos Lobos, Torres, RS, Brazil

The Wildlife Refuge of Ilha dos Lobos (WRIL), a marine protected island, located in Torres, southern Brazil, is the northernmost haul-out site with big aggregations of two species of Pinnipeds, the South American sea lion (Otaria flavescens), and the South American fur seal (Arctocephalus australis). Previous information on the abundance of pinnipeds, show data analyzed monthly or more spaced. Here, we present data from 71 censuses made between 2019 and 2020, with an average of 4 monthly counts, made by observations on land and boat with binoculars, cameras, and drone images. The seasonal variation revealed that the biggest concentration of pinnipeds happens during the winter and spring, with an average of 63.3 animals/day, and also showed a max occupation of both of the species in one day, 187 individuals in August/19. The most abundant species was Otaria flavescens, with sightings on
94.3% of the total censuses. The monthly mean abundance was higher in November/20 (mean: 73.67; SD: 2.51), October/20 (mean: 65.25; SD 15.09), and September/20 (mean: 58.25; SD: 34.9). Arctocephalus australis was present in 60% of the censuses, and the months of higher mean abundance was August/19 (mean: 81; SD: 77.78), and September/19 (mean: 35.14; SD: 31.82). Also, an Elephant seal (Mirounga leonina) was sighted in July/20. To better understand the distribution of pinnipeds in the exposed parts of the island, three sectors were created, using geological features as reference. O. flavescens was seen the most in middle sector, with 81% of sightings, followed by north sector with 17.1%. A. australis showed 38.8% of presence in middle sector, and 36.7% in south sector. With these results, we bring into consideration the importance of long-term weekly censuses for a precise understanding of the distribution of pinnipeds, and the relevance of the WRIL as a haul-out site for these animals.

Post-process Imaging Techniques of Field Photos to Create Morphologically Accurate 3-D Models of Large Marine Mammals
Audrey Kellogg1, Christin Murphy2, Sarah Kienle3, Marilyn Marx4, Joy Lapscheris5, Michael J Moore4

1New Jersey Institute of Technology, Chatham, New Jersey, 2US Navy, Newport, RI, 3Baylor University, McGregor, TX, 4Anderson Cabot Center for Ocean Life at New England Aquarium, Boston, MA, 5Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Photogrammetry is a quick, low-cost data collection technique we utilized to develop three-dimensional models of large marine mammals. Data collection of large marine mammals is not only limited due to size, but also the unpredictability of the stranding event location which restricts image collection by time, location, weather, and non-uniform conditions. 360° photo sequences of large marine mammals, two North Atlantic right whales (Eubalaena glacialis) and four leopard seals (Hydrurga leptonyx) were collected at stranding and tagging events, respectively. While we are unable to move these large marine mammals to ideal imaging locations, we can process the field collected photos to modify any variables that may prevent the reconstruction of an accurate 3-D model. After image collection, a combination of Adobe Photoshop, Blender, Maya, and Meshmixer were used to adjust the properties of the images before importing into photogrammetry software PhotoModeler. We were able to preserve the accuracy of the specimens in the 3-D model regardless of background, glare, or camera stability which allows for a more accurate computational analysis of the stranded specimens. We were also able to create accurate models with as few as 20 images. Testing different post-processing techniques on varied backgrounds, textures, lighting, and angles, we have created methodology that conserves the biological accuracy of the imaged species as compared to models developed without post-process editing. The developed methodology for each image defect was constructed into an open-source macro available on our GitHub Repository. Here we share the image processing methodology used on each photo series collected that produced a morphologically accurate 3-D model for computational analysis.

Sleeping while diving: the first recordings of marine mammal sleep in the wild
Jessica Kendall-Bar1, Daniel Lozano1, Julie Pitman2, Rachel Holser3, Roxanne Beltran4, Matt Schalles5, Cara Field6, Shawn Johnson7, Ding Zhang8, Alexei Vyssotski9, Daniel Costa10, Terrie Williams11

1Scripps Institution of Oceanography- Center for Marine Biotechnology & Biomedicine; UC San Diego, 2Sleep Health MD, San Jose, CA, 3University of California, Santa Cruz, Santa
Cruz, CA, 4University of California Santa Cruz, Felton, CA, 5Neuroscience Institute, Carnegie Mellon University, 6The Marine Mammal Center, Sausalito, California, 7The Marine Mammal Center, 8University of Michigan, Ann Arbor, MI, 9University of Zurich, Switzerland, 10Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, 11University of California Santa Cruz, Santa Cruz, California

Sleep studies of marine mammals have traditionally relied on invasive methods and captive animals. We performed the first electrophysiological recordings of marine mammal sleep in the wild with non-invasive surface mounted electrodes. We recorded signals during periods of rest on land, in shallow water (<2m), on the continental shelf (<200m), and in the open ocean (>200m). After refining our methods with anesthetized animals (N=11), we ruggedized and waterproofed a Neurologger© (©Evolocus) device to record several days of brain, eye, muscle, and heart activity, 3-axis inertial motion sensing, and environmental data (pressure, temperature, GPS, and illumination). These recordings were performed (A) on seals in temporary captivity in a 5-foot pool (N=5) and (B) in the wild at Año Nuevo State Park (N=5). In both environments, seals slept in short cycles with a stereotypic pattern from quiet waking to slow wave sleep, which were tied to apneas. After slow wave sleep, the seals often exhibited low voltage electrophysiological activity, characteristic of waking, and high heart rate variability, which we classified as paradoxical sleep (analogous to REM sleep in humans). Periods of electrophysiological sleep (slow wave sleep and paradoxical sleep) were recorded in seals on land, floating in shallow water, on the ocean floor in shallow water and on the continental shelf, and during open ocean drift dives. We recorded 26 rest periods lasting up to 16 minutes on the continental shelf between 70-180m and 3 drift dives with drift periods lasting 3.6, 5.6, and 8.6 minutes, respectively. While there was considerable variation in sleep patterns across individuals, total sleep time was lower in wild animals than in captive animals and lowest while sleeping at sea. While seeking to conserve marine mammal populations and critical resting habitats, we must study sleep within the natural context in which sleep evolved.

Booth in a Box – a Portable Tool for Inspiring Action for Any Whale Species
Jennifer Kennedy1, Cynde McInnis2, Nicole Downing3
1Blue Ocean Society for Marine Conservation, Portsmouth, New Hampshire, 2The Whalemobile, Topsfield, Massachusetts, 3Blue Ocean Society for Marine Conservation, Portsmouth, NH

In 2020, the Year of the Right Whale Project was launched to protect the North Atlantic right whale through celebration, education and action. A key strategy used in the effort was the innovative “Booth in a Box,” which includes tools to educate the public about right whales and encourage people to take action to protect them. Participants are taught about species anatomy, behavior and conservation through a right whale model, identification game, children’s activity booklet, displays, and more. The Box also includes talking points and instructions for educators. The Booth in a Box was freely available for educators, organizations and whale watch companies. Tools used in the Booth in a Box were also adapted for other local species. The Booth in a Box concept can be adapted for any species, so that scientists and educators can further knowledge about their primary/local species and inspire awareness and behavior change to increase conservation efforts. This presentation will showcase the activities from the Booth in a Box, discuss our distribution efforts and how tools were adapted for other local species. It will also provide the information needed for others to take these tools and adapt them to their own study species/local species for educational purposes.
Relationships between Total Mercury Concentrations and Stress-related Hormones in Lanugo of the Endangered Steller Sea Lions from Alaska and Russia

Mandy Keogh¹, Angela Gastaldi², Jason Waite³, Brian Fadely⁴, Lorrie Rea⁵, J Margaret Castellini⁶, Todd O’Hara⁷, Vladimir Burkanov⁸, John Maniscalco⁹
¹NOAA Alaska Region, Juneau, AK, ²University of Alaska Fairbanks, Fairbanks, Alaska (AK), ³Alaska Department of Fish & Game, Douglas, AK, ⁴NMFS/AFSC Marine Mammal Laboratory, Seattle, Washington, ⁵University of Alaska Fairbanks, Fairbanks, Alaska, ⁶University of Alaska Fairbanks, Fairbanks, Alaska, ⁷University of Alaska Fairbanks, Fairbanks, AK, ⁸Marine Mammal Laboratory, AFSC, NMFS, NOAA, Seattle, Washington, ⁹Alaska SeaLife Center, Seward, AK

The western distinct population segment (DPS) of Steller sea lions (Eumetopias jubatus, SSL) is endangered with metapopulations east of Samalga Pass increasing, while those to the west continue to decline. The cause of the variable trajectories between metapopulations within the western DPS remains unknown but there is increasing support that mercury exposure during in utero development may be a contributing factor. Total mercury concentrations ([THg]) in lanugo (fur grown in utero) in SSL pups were associated with variation in immune parameters. Mercury can also influence the hypothalamic–pituitary–adrenal (HPA) axis by binding to the adrenal glands, hypothalamus, or pituitary gland. In pinnipeds, secretion of aldosterone, cortisol, and corticosterone follows activation of the HPA axis by a stressor leading to changes in behavior and physiological status. We investigated the relationship of [THg] and measures of aldosterone, cortisol, and corticosterone (HPA axis status) using lanugo (n=1019). All hormones were measurable in all samples with mean ± SE pg/mg (range) as follows: aldosterone 3.7 ± 0.1 pg/mg (0.1 – 64.3), cortisol 18.1 ± 0.5 pg/mg (0.8 – 356.5), and corticosterone 19.1 ± 0.3 pg/mg (1.3 – 65.9). We found [THg] were related to concentrations of aldosterone (p=0.004), cortisol (p<0.001), and corticosterone (p<0.001). Though future studies are needed to understand if the relationship between [THg] and adrenal hormones influence growth and survival, our findings add to the growing evidence of in utero mercury exposure as a possible contributing factor to the population status of the western DPS SSL.

Pinnipeds, an order of semi-aquatic marine mammals, adapted a body design that allows for efficient aquatic locomotion but limited terrestrial locomotion. Phocids (true seals) have reduced forelimbs and are unable to bring their hindlimbs beneath them during terrestrial locomotion. Otariids, like the California sea lion (Zalophus californianus), have enlarged forelimbs and can bring their hindlimbs under the body to locomote quadrupedally on land. Due to these differences, phocids are expected to move on land with greater energetic costs compared to otariids. The mechanical costs of transport and power outputs of terrestrial locomotion were compared between the California sea lion (Zalophus californianus), and three phocid species (harbor seal, gray seal, and Northern elephant seal). One male and two female adult California sea lions were video recorded galloping across a level runway. The center of mass, along with six other anatomical points, were digitized to obtain variables such as velocity (V), amplitude of heave (A), and the frequency (f) of oscillations during the gallop cycle. These variables represent the principal
parameters of a biomechanical model that computes the power output of individuals. Power output and mechanical Cost of transport were calculated and compared between the four pinniped species following the animals’ center of mass. The quadrupedal gait of the California sea lion proved to have significantly lower costs of transport, power outputs, and vertical displacements compared to the terrestrial gait of the phocids. Therefore, California sea lions locomote more efficiently on land when compared to phocids; the gait of otariids being more similar to that of terrestrial mammals.

Outcomes and Recommendations from a Workshop on Marine Mammals and Offshore Wind Development on the US West Coast

Francine Kershaw¹, Sarah Courbis², Aude Pacini³, Kathryn White⁴, Sandy Aylesworth⁵
¹Natural Resources Defense Council, New York, New York, ²Advisian Worley Group, Portland, Oregon, ³Hawaii Institute of Marine Biology, Kane‘ohe, Hawaii, ⁴Advisian Worley Group, ⁵Natural Resources Defense Council, California

Interest in offshore wind continues to grow in California and now extends to Oregon. In 2016, Bureau of Ocean Energy Management (BOEM) received an unsolicited lease request for offshore wind off California, and a federal-state task force was formed. In 2018, BOEM published a Call for Information and Nominations for wind energy leases off CA. There are transferable lessons from the US East Coast regarding offshore wind and potential impacts to and permitting challenges for marine mammals, but the US West Coast is a different environment with different species compositions and use patterns, and different wind technologies bring different stressors. The Natural Resources Defense Council and Advisian Worley Group are conducting a US West Coast offshore wind/marine mammal workshop in summer 2021 to achieve the following goals: (1) identify existing or near-term available data, including archived data and determine its potential for integration into data portals or other public...
platforms; (2) identify relevant ongoing research and limitations affecting the research, such as funding constraints; (3) inspire collaboration and build relationships among researchers, and determine other scientists who should be engaged; (4) identify data gaps or data analyses gaps (in which data exist but they have not been formatted and analyzed in a way that addresses offshore wind questions); and (5) recommend next steps for developing research priorities and filling data gaps. We will describe our outcomes and recommendations from this workshop. From experience on the US East Coast, it is clear that regional collaboration will be key to reducing uncertainty, improving assessments, and adaptively managing potential effects of offshore wind on marine mammals. Early engagement with marine mammal researchers is key to ensuring collaboration, communication, and best use of resources to address challenges and take advantage of opportunities.

Geospatial Artificial Intelligence for Animals: Developing an Operational System for Detecting Marine Mammals in Very High Resolution Satellite Imagery

Christin Khan1, Kimberly Goetz2, Erin Murnane1, Timothy White3, Hannah Cubaynes4, Tyler Aldrich4, Danielle Cholewiak5, Caleb Robinson6, Anthony Ortiz8, Juan Lavista Ferres8
1NOAA Fisheries, East Falmouth, Massachusetts, 2NOAA-AFSC-MML, Seattle, WA, 3ARNOLD, MD, 4Bureau of Ocean Energy Management, 5British Antarctic Survey, 6National Oceanic and Atmospheric Administration, 7Northeast Fisheries Science Center / NOAA Fisheries, Woods Hole, Massachusetts, 8Microsoft

Monitoring whales and seals is of broad interest to government agencies, academic, and commercial institutions around the globe. The recent advancements in very high resolution (VHR) satellite imagery, cloud computing, and artificial intelligence have tremendous potential for the development of an operational system to detect marine mammals around the world. Recent research has demonstrated the feasibility of identifying whales from VHR satellite imagery with both manual and machine learning approaches. NOAA Fisheries, in collaboration with the Naval Research Laboratory, the Bureau of Ocean Energy Management, and the British Antarctic Survey, has been exploring the development of an operational system to detect marine mammals from VHR imagery. While still in the early stages, we hope to raise awareness in the research community of this effort and invite further information exchange. We have acquired large volumes of Maxar imagery over known seasonal aggregations of the North Atlantic right whale and the Cook Inlet beluga whale from WorldView-3, WorldView-2, and GeoEye satellites. Explorations into satellite imagery formats and processing has led to our decision to focus on the use of level 1B GeoTIFFs which are projected in UTM and to do our own pansharpening after image acquisition. We continue to explore different software platforms for image annotation and plan to annotate some imagery in the coming year in collaboration with Maxar’s GeoHive platform. The creation of a large standardized dataset of high quality annotations is a necessary precursor to successful machine learning approaches, and we will be working closely with the Microsoft AI for Earth program to develop marine mammal detection algorithms and cloud processing workflows. These efforts should lay the groundwork for future generations of scientists to have another tool in the toolbox as we seek to understand and protect marine mammals around the world.

Subsurface gillnetting as a mean of reducing Cetacean entanglement in tuna fishing in Pakistan

Muhammad Moazzam Khan, Marine Fisheries Department, Pakistan, KARACHI, SIND, Pakistan
Gillnetting is considered to be an important fishing gear in Pakistan and other countries of northern Indian Ocean including Iran, Oman, India, Yemen, Somalia and Sri Lanka. Gillnet are known for high bycatch of cetaceans including dolphins and whale. It is known that most cetaceans that entangle in gillnet die due to drowning. Studies initiated in Pakistan in 2012 indicated that annual cetacean mortality in gillnet operation can be as high as 12,000 along the Pakistan coast. Considering high mortality rate, a number of measures were taken, however, subsurface gillnetting was found to be the most appropriate and acceptable solution to fishermen engaged in tuna gillnetting. Placing net 2 m below the sea surface as compared to traditional surface gillnetting not only increases catch of target tuna species (yellowfin and skipjack tunas) but almost eliminate entanglement of dolphins. Adoption of subsurface gillnetting by tuna fleet in Pakistan resulted in reduction in the level of entanglement and mortality of dolphin. Prior to 2014, entire tuna gillnet fleet of Pakistan used surface gillnets, however, persuasion of WWF-Pakistan, fishermen started using gillnets that are placed about 2 m below the surface. By 2016, almost entire fleet shifted to subsurface Gillnetting which resulted in substantial decrease in dolphin entanglement from annual about 12,000 in 2013 to mere 186 in 2018 and only 66 in 2019. Subsurface gillnetting, therefore, is an effective mean of reducing dolphin bycatch in gillnet operations. Subsurface gillnetting is getting popularity in other regional countries such as Iran. In the paper, details about use of subsurface gillnetting, its level of acceptability and other technical details will be discussed.

Plasticity in the morphometrics and movements of an Antarctic apex predator, the leopard seal
Sarah Kienle1, Mike Goebel2, Erin LaBrecque3, Renato Borras-Chavez4, Stephen Trumble3, Shane Kanatous6, Daniel Crocker7, Daniel Costa8
1Baylor University, McGregor, TX, 2NOAA - Fisheries, 3U.S. Marine Mammal Commission, Bethesda, MD, 4Center of Applied Ecology and Sustainability-CAPES, Pontificia Universidad Catolica de Chile, Punta Arenas, Chile, 5Baylor University, Waco, Texas, 6Colorado State University, 7Sonoma State University, Rohnert Park, CA, 8Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA

Leopard seals (Hydrurga leptonyx) are apex predators in a rapidly changing Southern Ocean; how this species responds to environmental change depends on phenotypic plasticity. The scarcity of published data on leopard seals, however, makes it difficult to assess their ability to cope with environmental change. Therefore, our objective was to evaluate phenotypic plasticity in leopard seals by comparing variability in their movement patterns, dive behavior, and diet. To test this, we deployed satellite biologging instruments that transmitted for ~5 months (149+/−71 days) and collected physiological samples from 21 individuals in the South Shetland Islands in 2018 and 2019. We found that 57% of tagged leopard seals were transients, traveling 600-1,600 kilometers from the tagging location; the remaining 43% were residents that stayed within 300 kilometers of the tagging location. Leopard seals also showed variability in dive behavior. Sixty-five percent of leopard seals dove to a mean depth of 26+/−3 meters for a mean duration of 4+/−1 minutes; 24% took longer, deeper dives (41+/−6 meters, 4+/−1 minutes), and 11% took shorter, shallower dives (17+/−0 meters, 3+/−1 minutes). Similarly, diet analyses revealed that some leopard seals specialized on either ectothermic prey (e.g., fish, krill) or endothermic prey (e.g., Antarctic fur seals, gentoo and chinstrap penguins); while others were considered generalists, exhibiting seasonal shifts in diet and trophic position. Here, we demonstrate that leopard seals range from specialists to generalists, which results in the species occupying a broad ecological niche. Together, our results showcase a high level of
phenotypic plasticity in leopard seals from a single geographic location. We hypothesize that this plasticity characterizes the species across their range. This high degree of phenotypic plasticity is likely highly advantageous, allowing leopard seals to adapt and respond to the dynamic changes to their polar habitat.

Prenatal developmental stages of the Antarctic minke whale

Yujin Kim¹, Futaba Nishimura², Takeharu Bando¹, Yoshihiro Fujise⁴, Gen Nakamura⁵, Hiroto Murase⁶, Hidehiro Kato⁷
¹The Institute of Cetacean Research, Busan, South Korea, ²Kanagawa Prefectural Museum of Natural History, Kanagawa, Japan, ³The Institute of Cetacean Research, Chuo-ku, Tokyo, Japan, ⁴Institute of Cetacean Research, Tokyo, Japan, ⁵Tokyo University of Marine Science and Technology, Shiraoka, ⁶Tokyo University of Marine Science and Technology, Japan, ⁷Tokyo University of Marine Science and Technology/Institute of Cetacean Research, Tokyo, Japan

This study describes prenatal morphological development of the Antarctic minke whale based on the Carnegie stages (CS) and Fetal stages (FS). The morphological development from CS 14 to FS 27 is sequentially covered which has never been reported for this species. Morphological changes specific to this species associated with prenatal development are as follows. The second and third digits from the radial were similar in length at CS 17 and the longest, but in CS 18, the second digit was longer than the third, followed by the first and fourth digits. The dorsal fin and flukes began to develop in FS 20 and retained almost the same shape as postnatal at FS 24. Ventral grooves began to develop from FS 24 at the lower jaw and the armpit at the same time, and in FS 25 it covered up the body surface from the lower jaw to the thoracic ventral. This study reveals that the body parts related to swimming have develop in earlier stages than the parts related to feeding. As cetaceans returned to the water, they modified their morphology to adapt to aquatic environment. Acquisition of flukes occurred before divergence of Mysticeti and Odontoceti. In contrast, the baleen plate of Mysticeti was obtained after diverging from a common ancestor with Odontoceti. This similarity between prenatal development and morphological evolution suggests that the morphological evolution of cetaceans is reflected in the prenatal development of modern cetaceans. Because ventral grooves consist of soft tissues, they are not fossilized. As the results, it has not been known when Mysticeti acquired them in the evolutorial history. Analyzing the expression of genes associated with the development of ventral grooves considering their evolutionary history will be next step to the elucidation the timing of emergence of ventral grooves in Mysticeti.

The Survival of a Fluke-less Juvenile Dolphin (Tursiops aduncus) in the Wild.

Mi Yeon Kim¹, Soojin Jang², Jae Chun Choe³, Dong-Guk Paeng⁴, Shiro Kohshima⁵
¹Marine Animal Research and Conservation, ²Ewha Womans University, South Korea, ³Division of EcoScience, Ewha Womans University, Seoul, Seoul, Korea, Republic of, ⁴Department of Ocean System Engineering, Jeju National University, Jeju-si, Jeju Special Self-Governing Province, South Korea, ⁵Wildlife Research Center, Kyoto University, Kyoto, Japan

Among the leading causes of severe external injuries of marine mammals are vessel collision and fishing gear entanglement. However, some individuals show remarkable recovery from external injuries through rapid healing and behavioral adjustment. The external injuries caused by fishing gear such as ghost nets and fishing lines can be severe as they may cause whole body entanglement and/or fatal amputation of crucial body parts such as dorsal
fin, flippers, and tail. Herein, we report the observation of behavioral adjustments of a young Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) surviving with a complete tail-fluke amputation in the wild and discuss its implications on long-term injury adjustment and conservation concerns.

On 19 June 2019, tourists in a dolphin-watching yacht on the Kimnyeong located at the North East of Jeju Island witnessed a young dolphin without a tail. It was found again about four months later, in Daejeong, approximately 80km away. Like the previous reports, the individual was swimming by moving the peduncle left and right while moving dorsoventrally. The individual spent most of his time in Daejeong that provided more accessible prey items supplied by the aquacultures that discard unmarketable fish on the shore. The dolphins in Jeju Island often use these pipelines to scavenge for easy prey items in the Daejeong. Such prey availability could have been a crucial element in survival for the fluke-less individual. In 2020, the individual was no longer often seen in Daejeong, but he was within a group with improved swimming ability. In February 2021, the individual took part in a four-individual-group social-sexual behavior. This note demonstrated the importance of long-term monitoring for the accurate understanding of severe injury and the full extent of the recovery process. The remarkable unassisted survival of the fluke-less individual in the wild has implications for anthropogenic interventions towards the severely injured.

Davian Behavior in Common Bottlenose Dolphins (*Tursiops truncatus*) in the Sarasota, FL Area

Amber Lea Kincaid¹, Gretchen Lovewell², Jason Allen³, Kim Bassos-Hull³, Jessica Blackburn³, Rebecca Hazelkorn⁶, Randall Wells³

¹Mote Marine Laboratory and Aquarium, ²Mote Marine Laboratory, Sarasota, FL Florida, ³Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, Florida, ⁴Sarasota Dolphin Research Program/Mote Marine Laboratory, Sarasota, Florida, ⁵Mote Marine Laboratory, ⁶NOAA, National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, Florida

Davian behavior (necrophilia) has been reported in a variety of species across several chordate classes, including mammals, birds, reptiles, and amphibians. Proposed reasons for this behavior include facilitating copulation (e.g., anurans forcing oocytes from a dead female to fertilize), hormone stimulation, dominance assertion, and inappropriate stimulus response. Three separate observations of Davian behavior among common bottlenose dolphins (*Tursiops truncatus*) occurred in the Sarasota, FL area, with one observation each in 2016, 2018, and 2020. Each event involved one dead female and two live, pair-bonded males, none of whom were involved in more than one event. The males exhibited behaviors that included vocalizing, bumping and rubbing the carcasses, and escorting them as they were being towed to shore for recovery and necropsy. The 2020 case was the first documented observation of intromission between a live dolphin and dead conspecific. The 2020 event was also unique in that both of the males died in the subsequent two days following the observation (the subsequent necropsies revealed some similar, but inconclusive, findings). All nine dolphins involved in the documentation of Davian behavior were known to the Chicago Zoological Society’s Sarasota Dolphin Research Program, and all deceased dolphins (three females and two males) were necropsied by Mote Marine Laboratory’s Stranding Investigations Program. While no cause of death was determined for the females from the 2018 and 2020 events, intraspecific trauma was a possible cause of death for the female from the 2016 event. It is unclear what the benefits of such behavior with a dead conspecific are. Given that the mating attempts were unlikely to be for
procreation, alternatives include dominance assertion and physical pleasure, or a combination of the two. Future observations of this behavior will better enable us to understand the potential benefits.

Baleen whale distribution, behavior, and overlap with anthropogenic activity in coastal regions of the New York Bight
Carissa King¹, Emily Chou², Melinda Rekdahl², Sarah Trabue³, Howard Rosenbaum⁴

The New York Bight (NYB) is one of the busiest waterways along the U.S. East Coast, and has recently seen an apparent increase in baleen whale presence. With growing anthropogenic pressures, a better understanding of whale distribution and behavior is needed. Encounter rates (sightings km⁻¹) and behavior of humpback (Megaptera novaeangliae), fin (Balaenoptera physalus), and minke (Balaenoptera acutorostrata) whales were obtained from dedicated non-systematic small vessel surveys conducted from May–November 2017–2019 in previously under-surveyed coastal areas of the NYB. Humpback whales were sighted more frequently than fin and minke whales. Encounter rates were highest in the mid-shelf region (10–60 km from shore), where sightings of all species were generally concentrated spatially and temporally in mixed-species aggregations, and species were observed feeding on sand lance (Ammodytes spp.). In nearshore waters (<10 km from shore), sightings of all species were more dispersed and typically occurred in close proximity to Atlantic menhaden (Brevoortia tyrannus); humpback whales were commonly observed lunge feeding on these prey patches. The prevalence of foraging behavior documented throughout the study area supports the potential importance of the NYB as a supplemental and/or emergent primary feeding area for some baleen whale age-classes. Encounter rates were highest in areas overlapping with anthropogenic activity, suggesting that whales may be particularly vulnerable to anthropogenic impacts in the study area. The observed species distribution patterns and importance of the NYB as foraging habitat for baleen whales provides valuable information for the development of new baselines and best management practices within this heavily urbanized region.

Reduced Haulout Time Slows Molt in Postpartum Weddell Seals
Amy Kirkham¹, Skyla Walcott², Roxanne Beltran³, Jennifer Burns⁴
¹University of Alaska Fairbanks, ²CICOES, NOAA, Seattle, ³University of California Santa Cruz, Felton, CA, ⁴Texas Tech University, Lubbock, Texas

In many seal species, females that pup in a given year (postpartum females) complete the annual molt later than seals that skip reproduction (skip females), which can lead to increased thermoregulatory costs if ambient conditions are cooler. However, the relative importance of potential behavioral and physiological drivers of molt delay remains unresolved. To determine the underlying causes of delayed molt in postpartum Weddell seals (Leptonychotes weddellii), molt progression was tracked across the austral summer in 70 postpartum and 35 skip females using histological and gross examination of hair follicles and observations of shedding patterns. Mass, body condition, serum hormone levels, and time spent hauled out were all measured. Hair follicles were active in both skip and postpartum females at initial handling in late spring, indicating that parturition did not delay the start of the molt cycle. However, hair grew twice as fast in skip females, and the entire molt process from onset of hair synthesis to completion of shedding occurred over a much shorter period in skip versus postpartum seals.
(86±11 vs. 131±23 days). Rates of wound healing and local hair growth were also positively correlated, suggesting that molt and skin maintenance are closely linked. Model comparisons revealed that the protracted molt in postpartum females was primarily due to their greater foraging effort during midsummer. Reduced haulout time predicted slower molting, and postpartum females spent less time hauled out than skip females (44±6% vs. 63±6% of total time). Spending more time in cold, polar waters likely reduced skin perfusion and slowed hair follicle cycling in postpartum seals but was needed to recoup mass lost during the preceding lactation period. This study shows that reductions in sea ice platforms, foraging efficiency, or other constraints on hauling out may prolong or impair pinniped molt, increasing its energetic cost and compromising integumentary health.

Identifying fatty acids fueling non-foraging activity in the skeletal muscle of northern elephant seals (Mirounga angustirostris) during translocation studies
Aaron Kirkpatrick¹, Shane Kanatous², Daniel Crocker³, Stephen Trumble¹
¹Baylor University, Waco, Texas, ²Colorado State University, ³Sonoma State University, Rohnert Park, CA

Fatty acids are integral to the northern elephant seal’s ability to fast while on land, and fuel extended periods of deep-diving. Metabolic requirements of elephant seals vary by age or developmental stage, and up to 90% of these metabolic requirements can be fueled via fatty acid oxidation. Previously, fatty acid profiles in skeletal muscle and blubber in resting elephant seal age groups were characterized and found to vary due to developmental differences. These differences could relate to the period of diving development that occurs between weaning and becoming a deep-diving elephant seal. Here, we investigated fatty acid mobilization and metabolism in non-foraging activity through translocation studies. Elephant seals are an ideal model system for translocation studies, because they exhibit homing behavior, can be accurately relocated with the aid of tracking and diving tags, and can be monitored for post-release foraging. The metabolic requirements of shifting from a resting state to an active state requires fatty acids to be mobilized and transferred to skeletal muscle at a higher rate for oxidation, in order to power swimming. During translocation studies we hypothesized elephant seals would mobilize internal blubber reserves in response to increased fatty acid demands in skeletal muscle. Muscle and blubber biopsies were performed on four juvenile elephant seals, pre- and post-translocation. Preliminary data indicates all blubber profiles had increased proportions of saturated fatty acids (0.44%-15.14%) and decreased mono-unsaturated fatty acid proportions (3.30%-10.71%) post-translocation. Subjects differed in poly-unsaturated fatty acid proportions, with 2 subjects showing increased proportion in blubber and 2 showing decreased proportions. Skeletal muscle varied by individual subject in fatty acid proportions for each fatty acid group post-translocation. These data suggest that a similar pattern of mobilization may occur from blubber, but individual subjects’ diving ability may oxidize fatty acids differently in the working skeletal muscle during non-foraging activity.

Quality matters more than quantity: critically endangered Rice’s whales (Balaenoptera ricei nov sp) feed on high-energy but less abundant schooling prey
Jeremy Kiszka³, Michelle Caputo⁴, Johanna Vollenweider¹, Lance Garrison⁴
¹Florida International University, North Miami, Florida, ²Rhodes University and Florida International University, Port Elizabeth, South Africa, ³NOAA, ⁴Miami, FL

Investigating the feeding ecology of large marine predators is critical to understanding their roles
and importance in ecosystems. It is also important to understand the essential features of their habitats, including prey resources, to inform the development of conservation plans for endangered species. The newly described Rice’s whale (*Balaenoptera ricei*) is an endemic and critically endangered balaenopterid whale (abundance of 51 individuals, CV=0.50) occurring in the northeastern Gulf of Mexico. Available tag data suggest that Rice’s whale perform deep dives (150-250m deep) and forage near the bottom. However, the diet of this species is unknown and the species composition of the fish community in this region has received limited study. We investigated the feeding ecology of Rice’s whales in their primary habitat using a combination of skin biopsy samples, fish trawl collections, and analysis of prey samples collected during large vessel cruises in 2018 and 2019. Bulk stable carbon and nitrogen isotope analysis of whale skin samples and prey were used to assess diet composition. In addition, proximate composition analysis and the caloric content of potential prey were used to evaluate the energetic contribution of potential prey types. Bayesian stable isotope mixing models suggested that Rice’s whales feed primarily on a demersal schooling fish *Ariomma bondi* (66.8% relative contribution, SD=0.185). Smaller, but numerically dominant, vertically migrating fish including *Diaphus dumerilii*, a lanternfish (17.8% relative contribution, SD=0.174), and *Maurolicus weitzmani* (9.1% relative contribution, SD=0.075) made up less significant portions of the whales’ diet. These data suggest that the Rice’s whale has a specialized diet and may preferentially select for high-lipid and high-protein content prey. The high energetic costs of their foraging dives may be the key factor in driving this prey choice.

A maternal-investment index to aid conservation in whales, dolphins, and porpoises

Christopher Klein¹, Deby Cassill²
¹University of South Florida, St Petersburg, Florida; ²University of South Florida, St. Petersburg, FL

Cetaceans are known for their extensive maternal care. According to Maternal Risk Management (Cassill, 2019), cetaceans are scarcity-selected mammals that rely on extended maternal care in family units to successfully rear their offspring and sustain healthy population sizes. As indicators of vulnerability to climate change and anthropomorphic threats to cetaceans, studies of maternal investments, life histories, and ecological niches at a large scale have been largely absent due to data deficiency. Here, I present an integrated study of mean maternal investments, life histories and ecological niches across cetacean species. The study is based on a meta-data set of 92 species and subspecies. Using maternal investments and life history traits per species, I calculated the mean number of offspring produced in a decade per female per species. We used PCA and the Z coefficient per species to rank the 92 species and subspecies on a "relative population recovery capacity index." The index is an essential component to consider when assessing species vulnerability to climate change and anthropomorphic threats. This index will benefit our understanding of maternal investments at a larger scale and will provide conservation insight for cetacean species, including data deficient species.
Responses of Weddell seal (Leptonychotes weddellii) white blood cells to inflammatory stimulus
Amy Klink, Aranya Bagchi, Allyson Hindle
University of Nevada Las Vegas, Las Vegas, NV

Diving Weddell seals (Leptonychotes weddellii) experience repeated fluctuations between normoxia and hypoxia. A component of the cardiovascular response to diving is also a redistribution of cardiac output that favors vital organs (e.g. brain, lung, adrenals) while constricting blood flow to other regions. Ischemia-reperfusion injury (IRI) is the result of reduced blood flow and localized hypoxia, followed by reoxygenation and reperfusion. An inflammatory response that recruits monocytes to the injury site is associated with human IRI, resulting in a release of cytokines. In comparison to a human response, Weddell seal blood serum displays anti-inflammatory properties, suggesting a mechanism by which diving seals avoid IRI. The anti-inflammatory properties of Weddell seal serum mediate the induction of inflammatory cytokines in seal white blood cells, as well as in a mouse macrophage reporter system. Serum anti-inflammatory capabilities are found only in elite diving adult Weddell seals, but not in novice diving pups, suggesting a link with diving capacity. Moreover, although Weddell seal white blood cells demonstrate a robust response to the inflammatory stimulator LPS (300 fold induction of IL-6 gene expression), this is markedly lower than the response of human white blood cells (~1000 fold IL-6 induction). To further elucidate underlying cellular features, we compare Weddell seal monocytic transcriptomes to human monocytic transcriptomes after exposure to LPS. The response of immune cells to an inflammatory stressor may be an important component of molecular protection against IRI inflammatory sequelae in diving seals.

Ropeless gear testing in Maine waters in 2020 and 2021, including the first tests globally for removing Gillnet endlines to reduce whale entanglement.
Richard Zack Klyver, Blue Planet Strategies, LLC, Bar Harbor, ME

We report on the first tests of ropeless fishing gear systems in Maine waters. During the fall of 2020 we conducted 9 days of testing in the waters of Frenchman Bay and around Mount Desert Rock near Bar Harbor, Maine in 40’ to 457’ of water. Our team conducted 59 deployments of two gear types including SMELTS lobster and crab raft systems using compressed air and differing sized gear and air bags and the Edgetech 5112 gear system which uses a stowed rope that is released with buoys to the surface. Acoustic on demand modem systems from Teledyne and Fiomarine and the Edgetech acoustic release trigger were tested. Several successful subsea gear marking tests were made using the Teledyne Universal Topside system. Ranging tests were made to determine the distance from gear that the acoustic signal and we found that the Teledyne modem could both range and release at .7 miles. The Edgetech trap tracker app was used to mark gear at the surface. We used a compliant buoy and line during all testing and 39% of deployments were made with three non-fishing lobster traps with 90’ between each trap. Testing was conducted in deep water with high current and 12-foot tides and rocky and steep ocean seafloor. SMELTS gear was retrieved 50 out of 52 times or 96.2% with two instances of human caused error (opening the air tank, setting a timer). Edgetech gear was retrieved 12 of 13 times or 92.3% success with gear once being caught in rocky bottom with a steep incline. We report on testing being conducted in 2021 with commercial gillnet fishermen to remove the endlines and surface buoys and replace them with ropeless acoustic release systems. This project aims to reduce entanglement and derelict gear while advancing gear tracking technology.
Individual Variation of Epiphyseal Plate Fusion in Orcinus orca
Jamie Knaub1, Sheila Semans2, Marianne Porter3
1Florida Atlantic University, 2Noyo Center for Marine Science, 3Florida Atlantic University, Boca Raton, FL

Cetaceans are a diverse group of aquatic mammals that have undergone transitions in habitat and locomotive strategies over evolutionary time. Modern cetaceans are obligate swimmers that produce thrust using vertebral column undulations in a buoyant environment. Similar to terrestrial mammals, vertebral growth plates in cetaceans will fuse in cervical and caudal regions first and gradually advance inwards towards lumbar and thoracic regions. Previous research defined physical maturity in cetaceans, in part, by fusion of all epiphyseal plates, yet recent literature suggests this may not be true in all species. Cetacean vertebral columns may be influenced by ecological variables or life stage, and little is known regarding individual variation in growth plates. We aim to quantify fusion of epiphyseal plates in an adult male transient Orcinus orca that stranded deceased on the coast of Fort Bragg, CA in 2015. We hypothesized that 1) approximately 75% of epiphyseal plates will be completely fused, 2) cervical and caudal vertebrae will have the highest degree of epiphyseal fusion, and 3) the anterior epiphyseal plate will have a higher degree of fusion than the posterior plate on an individual vertebra. Observations of plate fusion were made by visual inspection and physical manipulation. Lateral view photographs were taken of individual vertebrae, images were converted to binary using ImageJ, and thresholding a region of interest on the plate provided pixel counts to assess the degree of fusion. Despite being an adult specimen, we found partial fusion in the late thoracic and early lumbar vertebrae. This specimen offered a unique opportunity to examine epiphyseal plate fusion in a large delphinid, which may vary from trends seen in other dolphin species. We believe complete fusion of all epiphyseal plates at physical maturity may be more rare than previously thought, however, foraging ecology and life history may impact individual variability.

Interchange of humpback whales (Megaptera novaeangliae) among Japanese areas using an automated matching system
Nozomi Kobayashi1, Satomi Kondo2, Koki Tsujii3, Katsuki Oki4, Masami Hida5, Takashi Yoshikawa6, Haruna Okabe7, Ryuta Ogawa2, Chonho Lee6, Naoto Higashi8, Ryosuke Okamoto9, Senzo Uchida9, Yoko Mitani10
1Okinawa Churashima Research Center, Okinawa Churashima Foundation, Motobu, Okinawa, Japan, 2Everlasting Nature of Asia (ELNA), Ogasawara Marine Center, Ogasawara, Tokyo, Japan, 3Ogasawara Whale Watching Association and Hokkaido University, Japan, 4Amami Whale and Dolphin Association, Amami, Kagoshima, Japan, 5Cybermedia Center, Osaka University, Ibaraki, Osaka, 6Cybermedia Center, Osaka University, Ibaraki, Osaka, Japan, 7Okinawa Churashima Research Center, Okinawa Churashima Foundation, Okinawa, Japan, 8Okinawa Churashima Foundation, Okinawa, Japan, 9Ogasawara Whale Watching Association, Ogasawara-mura, Tokyo, Japan, 10Okinawa Churashima Foundation, Motobu, Okinawa, Japan, 11Kyoto University, Hokkaido, Japan

Humpback whales in North Pacific migrate annually to low-latitude breeding areas including Japan in winter where the links between the humpback whale populations are still poorly understood. Using 3,620 fluke photo IDs from 3,620 unique individuals obtained by 5 independent research groups in 4 different areas in Japan; Hokkaido, 6 flukes (2016 and 2018), Ogasawara; (1) ELNA, 1,248 flukes (1987-2020), (2) OWA, 385 flukes (1990-2020), Amami, 373 flukes (1992-2016), Okinawa, 1,608 flukes (1991-2018), the interchanges of humpback whales within the Japanese areas were
analyzed. The fluke matching analysis between the areas was conducted by an automated matching system with 80.9% matching accuracy. The interchange indexes were also calculated according to the methodology obtained by Garrigue et al. (2002). As a result, there were 3 matches between Hokkaido and Okinawa (interchange index = 0.31), 29 matches between Amami and ELNA, Ogasawara (0.06), 11 matches between Amami and OWA, Ogasawara (0.08), 222 matches between Amami and Okinawa (0.37), 195 matches between Okinawa and ELNA, Ogasawara (0.10), and 50 matches between Okinawa and OWA, Ogasawara (0.08). The interchange indexes between Hokkaido and Okinawa, as well as between Amami and Okinawa were higher than 0.3, while the indexes between Ogasawara and all the other areas were lower than 0.1. The results indicate that the frequency of interchanges of humpback whales among Japanese areas is different depending on the areas. At the same time, interchange indexes among Japanese areas were much higher than the indexes between Japan (Ogasawara and Okinawa) and Hawaii (0.01) or Mexico (0.00), (Calambokidis et al. 2001). The results suggest that Japanese areas are utilized by the same population, but there is a possibility of the existence of several sub-populations migrating among Japanese areas. Further analysis with within-region return indexes for each area will reveal the links between the Japanese areas.

Management prioritization of specific Southern Resident killer whale life history components to address tradeoffs with salmon recovery and fisheries

Laura Koehn1, Lynne Barre2

1NOAA NMFS West Coast Region, Protected Resources, Seattle, WA, 2NOAA Fisheries, Seattle, Washington

Southern Resident killer whales (SRKWs) are endangered under the Endangered Species Act (ESA) and as of 2020, the population has declined to 72 whales. One of three main limiting factors to SRKW recovery is reduced prey quantity and quality, including SRKWs’ primary prey, Chinook salmon. Certain Chinook populations are ESA-listed themselves facing multiple threats, foremost being habitat degradation. Chinook are also a primary species for commercial, recreational, and tribal fisheries and essential to tribal culture and coastal communities. These multiple ecosystem services that Chinook salmon provide create tradeoffs between competing objectives – e.g. reducing fisheries to provide increased availability to SRKW can affect the economic resiliency of communities that depend on the fisheries. We highlight two management actions that make progress towards addressing tradeoffs through consideration of multiple objectives and prioritization of specifics of SRKW life history. In one action, Chinook stocks most important for SRKWs were identified based on SRKW diet data and spatial and temporal overlap to help guide Chinook hatchery operations and habitat actions, and prioritize projects which support SRKW and Chinook recovery. Second, low Chinook abundance levels that may signal higher risk for SRKWs were identified to inform a Chinook abundance threshold, below which additional fisheries management measures would be enacted in years when projected abundance is below the threshold. These include closures of SRKW foraging hotspots and quota limitations on non-tribal fisheries off of Washington Coast to provide protections in regions of top priority for SRKWs while still allowing Chinook fisheries in times/areas infrequently used by SRKWs, ensuring fishing communities most affected by further constraints to fishing still have access to important economic resources. We illustrate that it’s possible to find resolutions that consider life history and multiple objectives when endangered predators eat endangered prey and both are important to human communities, cultures, and economies.
Geographic distribution of non-lethal attacks on North Atlantic humpback whales by killer whales

Hana Koilpillai1, Charla Basran2, Simon Berrow3, Fredrik Broms4, Valerie Chossion5, Shannon Gowans6, Lindsey Jones7, Reg Kempen8, Finn Larsen9, Edda Magnúsdóttir10, Kris Prince11, Jooke Robbins12, Richard Sears13, Peter Simard14, Malene Simon15, Pádraig Whooley16, Frederick Wenzel17

1Eckerd College, 2University of Iceland - Husavik Research Center, 3Galway-Mayo Institute of Technology, 4North Norwegian Humpback Whale Catalogue, Kvaloya, Norway, 5Marine and Freshwater Research Institute of Iceland, Iceland, 6Eckerd College, St Petersburg, FL, 7College of the Atlantic, 8Port Rexton, Newfoundland, 9Institute of Aquatic Resources, Technical University of Denmark, Kgs. Lyngby, Denmark, 10University of Iceland, Reykjavik, Iceland, 11Sea of Whales, 12Center for Coastal Studies, Provincetown, Massachusetts, 13Mingan Island Cetacean Study, St Lambert, 14Eckerd College, St. Petersburg, FL, 15Nuuk, Greenland, Greenland, 16Irish Whale and Dolphin Group, Kilrush, Clare, Ireland, 17Protected Species Branch, NOAA, NMFS, Woods Hole, MA

While lethal attacks are rarely documented, non-lethal interactions between the killer whale, Orcinus orca, and the humpback whale, Megaptera novaeangliae, can be inferred from scars on humpback whale flukes. In this study, the North Atlantic, Irish, and North Norwegian Humpback Whale Catalogs were studied for evidence of non-lethal encounters between humpbacks and killer whales across the North Atlantic. Humpback whale flukes (N=10,546) were systematically evaluated by two reviewers for the presence and severity of killer whale scarification (rake marks or teeth indentations). Injuries, when present, were coded as light, moderate, or severe based on the degree of scarification, including missing fluke tissue as a result of a killer whale bite(s). The proportion of humpbacks with killer whale scarring across several mid- to high-latitude feeding grounds was consistent with prior studies: the Gulf of Maine (13.5%), Atlantic Canada (21.7%), West Greenland (15.5%), and Norway including the Barents Sea (7.9%). For the first time, we included results based on data from East Greenland (combined with Iceland, 9.3%) and the British Isles (Ireland, Scotland, and England, 11.0%). We also provided new evidence that the distribution of the degree of scarification (light, moderate, severe) was not statistically significant across the North Atlantic feeding grounds (Kruskal-Wallis ANOVA, p>0.05). However, this difference remained important to note: East Greenland/Iceland had the highest proportion of severely scarred individuals (10.7%) compared to the rest of the North Atlantic (0-3.4%). These results may reflect differential migratory patterns and predation risks of an Endangered population of humpback whales that breed in the eastern North Atlantic.

Kinematics of foraging behavior in newly described Rice’s whale

Annebelle Kok1, John Hildebrand2, Melissa Soldevilla3, Lance Garrison4

1Scripps Institution of Oceanography, La Jolla, CA, 2Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, 3Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL, 4Miami, FL

The recently recognized Rice’s whale (Balaenoptera ricei) is an understudied mysticete species. Its estimated small population size and restricted habitat in the Gulf of Mexico make it vulnerable for extinction. As part of a larger collaborative study to understand the trophic ecology and habitat of this species, we studied the kinematics of Rice’s whale foraging behavior. Using suction-cup archival tags, we investigated the kinematics of lunge feeding and resting behavior of two individuals. Despite the low sample size, the long attachment of both tags of more than a day made it possible to investigate
energy expenditure for a full diel cycle. Foraging lunges occurred primarily during daylight hours and near the sea bottom at depths between 200 and 275m. The lunges were preceded by circling behavior, likely to detect or round up prey. Both individuals showed distinctive, highly energetic lunge feeding, while variability in dive behavior suggested that one individual targeted the deep scattering layer, while the other foraged near the bottom. In comparison to otherrorqual species, the two tagged Rice’s whales made very few lunges while at depth, averaging 1.5 lunges per dive. Furthermore, the kinematic data were used to get an estimate of work done, which lined up with theoretical predictions. Elucidating the energy budget of the Rice’s whale is essential to understand their resilience to changes in foraging habitat, which could help to determine conservation priorities for this species.

Small Vessels Have a Big Impact at Local Scales in Southern Resident Killer Whale Critical Habitat
Christine Konrad Clarke¹, Svein Vagle², Rianna Burnham³, Scott Toews⁴, Sheila J. Thornton⁵
¹Fisheries and Oceans Canada, ²Fisheries and Oceans Canada, Sidney, ³Fisheries and Oceans Canada, Victoria, British Columbia, ⁴Fisheries and Oceans Canada, Vancouver, British Columbia, ⁵DFO - Fisheries and Oceans Canada, West Vancouver, British Columbia

Physical and acoustic disturbance from vessels has been identified as a primary threat to the endangered Southern Resident Killer Whale (Orcinus orca; SRKW) population, found in the northeast Pacific. Within SRKW critical habitat, potential impacts from the presence of large commercial vessels, such as cargo vessels and ferries, can be quantified using Automatic Identification System (AIS) data. However, vessel types that are not required to carry AIS, such as pleasure craft, are largely absent from these datasets. Yet, they have been shown to affect SRKW behaviour. Here, we analysed acoustic data from six underwater recorders using an acoustic metric centered at 50 kHz to characterise the presence of small vessels and their impact on the soundscape within SRKW critical habitat. In particular, we considered the potential of vessel noise to obscure echolocation signals, in the range of 15-100 kHz. Concurrent visual observations of recreational vessels from aerial surveys (May-October, 2018-2020) added to the analysis of small vessel presence. We identified daily and seasonal patterns of ambient noise in SRKW echolocation frequencies, whereby noise levels in the 50 kHz range were significantly greater for weekends compare to weekdays during the summer. This elevation in noise decreased the potential range over which echolocation could be used to locate prey. We attributed these acoustic impacts to small recreational vessels, which we substantiated with records of voluntary AIS vessels and visual observations of vessels near the recorder locations. Our study demonstrates the potential for recreational vessels to have substantial impacts on SRKW habitat, with implications for SRKW foraging success. We also show that these impacts vary spatiotemporally, resulting in habitat degradation that is dynamic. Understanding this variation in recreational vessel presence and its impact is an important part of characterizing the breadth of habitat quality experienced by SRKW.

Trace Elements in Peruvian Pinniped Vibrissae at Punta San Juan, Peru
Catherine Kooyomjian¹, Dimitrios Giarikos², Michael Adkesson³, Amy C. Hirons⁴
¹Nova Southeastern University, West Boylston, MA, ²Nova Southeastern University, Ft. Lauderdale, ³Chicago Zoological Society, Brookfield, IL, ⁴Nova Southeastern University, Dania Beach, FL

Two sympatric pinniped species, Peruvian fur seals (Arctocephalus australis unnamed ssp.;
PFS) and South American sea lions (Otaria byronia; SASL), have significant rookeries at the Punta San Juan reserve (PSJ) in southern Peru. Both species have experienced population fluctuations linked to natural and anthropogenic events. We examined trace elements in PFS and SASL vibrissae (whiskers) from 2011 to 2019 via induced coupled plasma mass spectrometry (ICP-MS). All non-essential elements analyzed (Al, As, Cd, Pb, Hg, Sn) were detected in vibrissae, suggesting that vibrissae may be used as an offloading route for contaminants in Peruvian pinnipeds. Overall, vibrissae As concentrations increased from 2011 to 2019. Arsenic bioaccumulates in marine organisms and potential sources for these increased As concentrations are agricultural runoff and Cu mining, both growing industries in southern Peru. Female SASL vibrissae contained As concentrations three times higher than SASL males and twice as high as PFS males and females. Since SASL females generally feed closer to shore than other pinnipeds at PSJ, they are at increased risk of exposure to coastal contaminants. Male SASL sampled were younger than PFS males but had Cd concentrations five times higher than PFS. Young SASL males likely forage on prey high in Cd, such as squid, not commonly consumed by PFS males. Copper and Zn were higher in PFS than SASL, indicating probable foraging differences between species. For both species, females had significantly higher concentrations of Cu and Zn and significantly lower concentrations of Cd and Hg compared to males. Females may utilize other routes of offloading non-essential elements such as gestation and/or lactation. This study is the first to determine trace element concentrations in vibrissae of pinnipeds at Punta San Juan.

Spatiotemporal pattern of vessel-cetacean collision risk in Hong Kong waters before and during the COVID-19 pandemic

Brian Chin Wing Kot¹, Aris Cheuk Sing Cheng², Tabris Yik To Chung¹, Henry Chun Lok Tsui¹
¹City University of Hong Kong, Hong Kong, China, ²City University of Hong Kong, Hong Kong S.A.R., China

Indo-Pacific humpback dolphins (Sousa chinensis) and Indo-Pacific finless porpoises (Neophocaena phocaenoides) are the endangered resident cetacean species in Hong Kong waters, both with low abundance estimates and high incidences of stranding. Previous reports indicated vessel encounter as a significant cause of mortalities, with stranded carcasses presenting various traumatic injuries and strike deaths. Blunt and sharp force trauma were indicative of vessel interactions in the busy port with heavy maritime traffic. Since the commencement of the COVID-19 pandemic, governments all around the world have obliged to implement confinement and social distancing measures, which casted an impact on global maritime mobility. We used encounter rate model based on cetacean distribution data and maritime traffic data to examine the spatiotemporal patterns of vessel-cetacean collision risk in Hong Kong waters. Line transect data from various environmental monitoring and audit programmes were combined to deduce the cetacean density estimates. Marine traffic data acquired from automatic identification system were filtered and processed using specific algorithm to calculate the vessel density. Reduction of marine traffic during the COVID-19 pandemic between 2019 and 2021 has given us an opportunity to pinpoint the cetacean-vessel encounter hotspots, which were indicated around the Soko Islands and Tai A Chau. Cetacean behavior and diurnal habitat usage will also be included in future studies for a more comprehensive analysis. Our results allow for strategic planning of future infrastructural developments and maritime routing via additional mitigation for protection of the endangered cetaceans at risk in Hong Kong waters.
Morphometrics of mammal-eating killer whales from drone photogrammetry, with comparison to sympatric fish-eating killer whales in the eastern North Pacific
Chloe Kotik¹, John Durban², Holly Fearnbach³, Lance Barrett-Lennard⁴
¹Scripps Institution of Oceanography, ²Oregon State University, ³SR3, SeaLife Response, Rehabilitation and Research, Seattle, WA, ⁴Coastal Ocean Research Institute, Vancouver Aquarium, Vancouver, British Columbia

Aerial photogrammetry data has provided evidence of nutritional stress in endangered Southern Resident killer whales (SRKWs, Orcinus orca) of the eastern North Pacific. It has also been used to correlate the growth and body condition of individuals with the availability of their primary prey, Chinook salmon (Oncorhynchus tshawytscha). To further elucidate the short- and long-term impacts of nutritional stress upon these predators, we collected similar aerial data from the sympatric population of mammal-eating Bigg’s killer whales (BKWs), which have been increasing in abundance over recent decades as SRKWs have declined. From 2014 to 2019 we used non-invasive drones to collect 20,545 high-quality photographs of 95 individually-identified BKWs. We combined this dataset with an existing photographic identification catalog to link known data on age and sex with novel photogrammetric estimates of size and body condition. Our sample was broadly inclusive of all age/sex classes, and individual length estimates ranged from 2.4m in a neonate to 8.3m in an adult male. We estimated asymptotic lengths of 6.4m (SE 0.1m, n = 41) for adult female and 7.3m (SE 0.2m, n = 26) for adult male BKWs, both significantly longer than the corresponding estimates for SRKWs of each sex (female z-test P = 0.003; male z-test P = 0.093). However, we found no significant difference in neonatal size or the age at which growth slowed (male z-test P = 0.53; female z-test, P = 0.45) between the populations. Using the Eye Patch Ratio metric as a proxy for body condition, we estimated that all age/sex classes of BKWs were more robust than SRKWs (ANOVA, P < 0.0001). Given that BKWs prey upon abundant marine mammal populations while SRKWs are thought to be at least periodically food-limited, we hypothesize that the observed variances in condition and length are functions of differential prey availability in the short- and long-term, respectively.

Spatial Use of Pantropical Spotted Dolphins in Relation to Stock Boundaries and Environmental Features in Hawaiian Waters
Michaela Kratofil¹, Robin Baird², Daniel Webster²
¹Cascadia Research Collective, Oregon State University, ²Cascadia Research Collective, Olympia, WA

Genetic studies and sighting distributions were used to delineate four stocks of pantropical spotted dolphins in Hawaiian waters: a pelagic stock and insular stocks off Hawai’i, Maui Nui, and O’ahu. Information on short-term movements and spatial use in Hawai’i is limited, yet such information is critical to their conservation, particularly in light of recent documentation of frequent interactions between fishing vessels and spotted dolphins throughout the main Hawaiian Islands. To examine spatial use, we satellite-tagged eight individuals from 2015 through 2018 (Kaua’i (pelagic), n=2; O’ahu, n=2; Maui Nui, n=2; Hawai’i, n=1) and tracked their locations from 7-21 days (median=14 days). The pelagic dolphins and one O’ahu individual (SaTag004) moved over a wide range (199-324km maximum displacement from tagging location) while all other insular dolphins remained near their tagging location (maximum displacements: 54-80 km) despite moving cumulative straight-line distances up to 1,490km. Insular spotted dolphins used nearshore waters associated with island slopes (median distances from shore: 11.2-29.5km), although exhibited...
some inshore/offshore movements (maximum distances: 29.2-63.5km), whereas pelagic dolphins used waters farther offshore (median distances: 45.3-54.2km; maximum distances: 114.8-148.3km). Pelagic dolphins, the Hawai‘i dolphin, and one O‘ahu dolphin (SaTag002) used deeper waters (median depths: 2,645-3,701m) compared to individuals tagged within the Maui Nui stock and SaTag004 (median depths: 657-798m). Four of five insular dolphins frequently moved across recognized stock boundaries with one individual moving across all three insular stock boundaries, and pelagic dolphins overlapped ranges of insular dolphins off O‘ahu. Insular dolphins were predominantly characterized by low move persistence (persistence in speed and direction), while pelagic dolphins more frequently exhibited periods of high move persistence. Our results advance understanding of pantropical spotted dolphin movement patterns and spatial use in Hawaiian waters and their variability among stocks and indicate that current stock boundaries do not appropriately represent the range of these populations.

Crash and learn? The rapid population collapse of Antarctic fur seal colonies in the northern Antarctic Peninsula endangers genetic diversity and resilience to climate change

Douglas Krause\textsuperscript{1}, Carolina Bonin\textsuperscript{2}, Mike Goebel\textsuperscript{1}, Christian Reiss\textsuperscript{1}, George Watters\textsuperscript{1}
\textsuperscript{1}NOAA Fisheries, La Jolla, California, \textsuperscript{2}Hampton University, Marine and Environmental Science Department, Hampton, Virginia, \textsuperscript{1}NOAA - Fisheries, \textsuperscript{1}NOAA Fisheries

Antarctic fur seals (AFS) are an ecologically important predator and a focal indicator species for ecosystem-based Antarctic fisheries management. This species suffered intensive anthropogenic exploitation until the early 1900s, but recolonized most of its former distribution, including the southern-most colony at Cape Shirreff, South Shetland Islands (SSI). The IUCN describes a single, global AFS population of least concern; however, extensive genetic analyses clearly identify four distinct breeding stocks, including one in the SSI. To update the population status of SSI AFS, we analyzed 20 years of field-based data including population counts, body size and condition, natality, recruitment, foraging behaviors, return rates, and pup mortality at the largest SSI colony. Our findings show a precipitous decline in AFS abundance (86% decrease since 2007), likely driven by leopard seal predation (increasing since 2001, \( p < 0.001 \)) and potentially worsening summer foraging conditions. We estimated that leopard seals consumed an average of 69.3\% (range: 50.3 – 80.9\%) of all AFS pups born each year since 2010. AFS foraging-trip durations, an index of their foraging habitat quality, were consistent with decreasing krill and fish availability. Significant improvement in the age-specific over-winter body condition of AFS indicates that observed population declines are driven by processes local to the northern Antarctic Peninsula. The loss of SSI AFS would substantially reduce the genetic diversity of the species, and decrease its resilience to climate change. There is an urgent need to reevaluate the conservation status of Antarctic fur seals, particularly for the rapidly declining SSI population.

Scarcity of Ribbon Seals During 2018 Bering Sea Visual Survey: An Acoustic Investigation

Ildiko Kremper, Western Washington University (alumna), Monroe, Washington

Ribbon seals are strongly associated with seasonal sea ice that forms in the Bering Sea, hauling out on the surface from mid-March to July to mate, give birth, molt, and raise their young. In 2018 only a few ribbon seals were sighted by the NOAA Ice Seal Vessel Survey, and that same year held one of the lowest sea ice extents on record. It was unknown whether the
lack of sightings was due to a mortality event, or if the spatial distribution of the species had changed. The extreme conditions and remote location of ribbon seal habitat make traditional ship-based or on-ice research logistically challenging. While annual surveys are cost-prohibitive, recordings from hydrophone moorings stationed in the region allow for analysis of ribbon seal acoustic activity to better understand their distribution. This study identified locations of high downsweep call activity consistent with the mating activity of ribbon seals in the Bering and Chukchi seas. A semi-automated detector was developed to identify downsweeps, a call type associated with ribbon seal mating activity. The detector was created using a custom R-based software, INSTINCT, and results were manually verified and compiled. The detector was deployed on 10 moorings in the Bering and Chukchi Seas, representing recordings from April to May of 2018 and 2019, associated with record low ice extent. The study included 2012 as a baseline year with a normal ice extent. In the low ice extent years, preliminary results indicate that ribbon seals were much further north than seasonally expected, with the majority of downsweeps detected in the northern Bering rather than the south. These results suggest that the seals shifted to areas where stable ice still remained, which was outside the surveyed area.

Masking effects of seismic airguns and other anthropogenic noise sources on blue whale communication
Hannah Kriesell, Norwegian University of Science and Technology

Previous studies studied the impacts of airgun blasts during seismic acquisition on cetaceans and have described avoidance behaviour, changes in vocalization rates, and auditory masking effects. Most of the work focused on behavioral responses based on visual observations or experimentally acquired hearing thresholds or temporary threshold shifts. Meanwhile, recent geophysical studies provide new insights into physical aspects of seismic sound generation and propagation, e.g. the emission of high frequencies (>5kHz) resulting from ghost cavitation and frequency-dependent amplitudes of air gun arrays fired at long distances (10-100 km) with increasing water depth. To understand potential masking effects of airgun noise on blue whale vocalizations in deep waters, we modeled the vocalization signal that a conspecific blue whale would be exposed to in a scenario where an airgun is being fired. The airgun source signals were acquired during a seismic test survey where the shooting vessel was equipped with three conventional air gun subarrays, and several shot lines crossing vertically above a stationary hydrophone permanently placed at the seafloor. The received signal is then generated based on a geometrical propagation model, considering the bathymetry and sound profile of the area of interest. The model results are further interpreted using audiograms of baleen whales taken from the literature to make assumptions about the audibility of the seismic shooting and the conspecific blue whale call that underwent acoustic masking. First results of acoustic tags deployed on humpback and killer whales in Northern Norway are presented.

Elevated Blubber Cortisol in an Endangered Beluga Whale (Delphinapterus leucas) Population Is Not Related to Diet
Caila Kucheravy¹, Steven Ferguson², Cortney Watt³, Jim Roth¹, Marci Trana¹, Gary Anderson⁴, Gregg Tomy⁵
¹University of Manitoba, WINNIPEG, MB, ²Fisheries and Oceans Canada, Winnipeg, Manitoba, ³University of Manitoba, Winnipeg, Manitoba, ⁴University of Manitoba

Changing conditions in the Arctic have led to shifts in community structure and food web dynamics, which have had severe consequences
for many marine mammals. One way to assess the impact of anthropogenic stressors on individual and population health in marine mammals is through blubber cortisol, an indicator of chronic stress. We examined blubber cortisol measured using radioimmunoassay in four Canadian beluga whale (*Delphinapterus leucas*) populations and found that the Cumberland Sound stock, which is listed on the Species at Risk Act, had the highest cortisol levels (0.65 ± 0.11 ng/g (± SE)). Cortisol concentrations from Cumberland Sound beluga whales were higher than Eastern Beaufort Sea (0.31 ± 0.03 ng/g), Eastern High Arctic-Baffin Bay (0.32 ± 0.09 ng/g) and Western Hudson Bay (0.44 ± 0.04 ng/g). To evaluate if measured cortisol differences were due to differences in diet we compared stable isotope ratios and dietary fatty acids among populations. Eastern Beaufort Sea had a significantly lower δ¹³C and higher δ¹⁵N, while Western Hudson Bay had a unique dietary fatty acid profile. Population and sex were significant predictors of blubber cortisol, with females exhibiting higher cortisol than males. Despite diet differences among populations, neither stable isotopes nor fatty acids were significant predictors of cortisol, suggesting differences in cortisol levels were unrelated to diet. Other factors such as increased risk of predation, hunting pressure, vessel traffic, and possibly other impacts of changing environmental conditions may be contributing to elevated stress levels in Cumberland Sound belugas. Measuring blubber cortisol as an indicator of chronic stress is a useful method for monitoring population health and can be used to inform management decisions.

**Music to my Ears: New Insights Into How Humpback Whale Song Chorusing can Inform Their Ecology**

Anke Kügler¹, Marc Lammers², Eden Zang³, Adam Pack⁴

¹Hawaii Institute of Marine Biology, Kaneohe, Hawaii, ²Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, HI, ³University of Hawaii at Hilo, Hilo, Hawaii

During the winter months (December-April) male humpback whale singing becomes the dominant source of low frequency (0-1.5 kHz) ambient noise in the marine soundscape of the Hawaiian Archipelago. While seasonal male chorusing levels mirror the migratory patterns and varying abundance levels of singers, they may also, in theory, reflect the overall abundance of humpbacks in the same area including juveniles and mother-calf pairs that can be acoustically cryptic on the breeding grounds. However, to date, the relationship between chorusing levels and overall whale numbers has been poorly defined. To address this, we collected long-term PAM data with bottom-moored recorders during the seasons of 2014/15 through 2019/20 off West Maui and calculated daily median root-mean-square sound pressure levels (RMS SPLs). Concurrent weekly visual surveys from a land-based station (2017-2020) and 16 line-transect vessel surveys (2019 and 2020) were conducted in the same study area. Combining the visual and acoustic data, we showed a strong positive quadratic correlation between SPLs and whale numbers, including non-singing animals (land: 0.72 ≤ R² ≤ 0.75, vessel: 0.87 ≤ R² ≤ 0.92 for three different PAM locations). Applying these results, we were able to use PAM to document significant population fluctuations between 2015 and 2020 (SPL decreases between 5.6 and 9.7 dB re 1 µPa² during the peak of the season), as well as study habitat use patterns. We found that whales do not use the region haphazardly, but appear to cluster in time and space. Effective long-term management relies on understanding how a species utilizes its environment and early detection of population-level abundance changes. While traditional survey methods (e.g. vessel, land, aerial) are valuable, they are often limited by weather, accessibility, and funding. Our
findings demonstrate that PAM is a relatively low-cost, robust complement and alternative for studying and monitoring humpback whales in their breeding grounds.

Influence of Prey Size Selection on the Foraging Behavior of Northern Fur Seals Revealed by Animal-borne Video
Carey Kuhn¹, Jeremy Sterling², Calvin Mordy¹, Molly McCormley², Burlyn Birkemeier², Angel Sar³
¹Marine Mammal Laboratory, Alaska Fisheries Science Center/NOAA, Seattle, Washington, ²Marine Mammal Laboratory, Alaska Fisheries Science Center/NOAA, Seattle, WA, ³Cooperative Institute for Climate, Ocean, and Ecosystem Studies, University of Washington, Seattle, ⁴CICOES, University of Washington, ⁵Cooperative Institute for Climate, Ocean, and Ecosystem Studies, University of Washington

A key aspect of foraging ecology research is understanding how predator foraging behavior and success are influenced by variation in prey resources. For northern fur seals (Callorhinus ursinus, NFS), an understanding of predator-prey relationships is critical to help identify potential causes for the unexplained population decline. We used satellite-linked dive recorders and animal-borne video cameras to examine how foraging behavior differs based on prey size selection. NFS were tracked on St. Paul and St. George islands (Alaska, USA) in September (2017, n=2) and August (2018, n=3, and 2019, n=2). We categorized prey captures based on relative prey size (small vs. large) and examined differences in capture depth, time of day, water temperature, and depth relative to the mixed layer depth (MLD). Over 1900 successful capture events were recorded with the majority being small prey (90.4%) captured at night (92.5%) but there was significant variation among individuals. Small and large prey were captured throughout the water column but large prey were primarily captured at deeper depths and below the MLD. Large prey were also captured at colder water temperatures, but not colder than expected based on the relationship between water depth and temperature. Although prey species could not be identified for most capture events, the fur seals diet in this region is dominated by a single species, walleye pollock (Gadus chalcogrammus). This suggests that differences in foraging behavior were related to NFS targeting different pollock age-classes. This enhanced understanding of NFS-pollock relationships will be useful to better interpret a historical NFS dive and tracking dataset that includes over one million dives and 6000 days of foraging. In addition, it will provide insight into how NFS may respond to future variation in prey resources, which is essential to develop ecosystem-based approaches for NFS conservation and fisheries management.

Gray whale (Eschrichtius robustus) research off Northeastern Sakhalin in 2019-2020
Anastasia Kunitsa¹, Alexandr Burdin²
¹Lomonosov Moscow State University, Russia, ²Petropavlovsk-Kamchatsky, Russian Federation

Western or Okhotsk-Korean population of gray whales is listed in the Red Book of Russia and IUCN list of endangered species in the category of “Critically endangered”. In 2019-2020, long-term studies (1995-2020) of the feeding group of gray whales off the north-east coast of the Sakhalin island in the Piltun feeding area were continued. Population studies are carried out from early July to mid-September. The main research methods are photo-identification of individuals and collection of biopsy samples. In addition, we are using drones for behavior observation. 81 gray whales were identified over two field seasons (2019- 2020). 33 (28 calves and 5 whales at age 1+) had not previously been seen in the Piltun feeding area. In 2019, 21 new whales for the catalog were registered, of which 20 were calves, which is a maximum number in the entire history of many years of research, and
only one aged 1+ has not previously been seen in the Piltun Lagoon area. 14 calves came to the feeding area with their mothers, and 6 calves, during the study period, were observed in the area without mothers. In 2020, out of 12 new whales sighted in the Piltun area, 8 were calves and were sighted during the period of work with their mothers. The catalog of the Sakhalin feeding group of gray whales represents 314 individuals, including new gray whales (calves and age 1+) sighted in the Piltun feeding area in 2019 and 2020. Long-term regular monitoring suggests that the recovery of the western gray whale population is positive. Analysis of the data shows that this grouping annually increases by 2-5%.

High recovery potential for the critically endangered vaquita
Jacqueline Robinson¹, Christopher Kyriazis², Barbara Taylor¹, Annabel Beichman¹, Sergio Nigenda¹, Kirk Lohmueller¹, Lorenzo Rojas-Bracho³, Robert Wayne⁴, Phillip Morin (he/him)⁵ ¹UCSF, ²UCLA, Santa Monica, CO, ³SW Fisheries Science Center, La Jolla, CA, ⁴Ocean Wise, Ensenada, Baja California, Mexico, ⁵Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, La Jolla, CA

The question of whether inbreeding depressing will doom species that have experienced recent and severe declines is often raised when costs to save the species are high. This is a critical issue for the most endangered marine mammal, the vaquita porpoise, endemic to the northern Gulf of California. The vaquita has experienced a catastrophic population decline driven by high gillnet bycatch, with roughly 10 individuals remaining from a population formerly of several thousand. Due to this extreme decline and low genetic diversity, it has been proposed that vaquitas are doomed to extinction by inbreeding depression, and that the high expense to shift fishers to alternative gear cannot be justified. To better gauge vaquita population history and the potential for inbreeding depression, we generated a whole genome sequence dataset from 20 vaquita individuals. We first demonstrate that low diversity is a natural characteristic of the vaquita due to their small historical population size, and not a consequence of the recent decline. We corroborate this finding with stochastic, individual based simulations, which similarly suggest that the vaquita has a low risk of severe inbreeding depression due to its small historical population size. We project population trends over the next 50 years, finding that recovery is possible if bycatch mortality is immediately halted. However, we also demonstrate that even modest rates of continuing bycatch mortality result in an appreciable extinction risk. Our results demonstrate hope for vaquita recovery and highlight the applicability of genomic data in conservation of rare and endangered species.

Citizen scientist training and the accuracy of acoustic data labeling for files with manatee calls and mastication sounds
Natalija Lace, Cetalingua Research Project, Tampa, Florida

Deep Convolutional Neural Networks models’ accurate classification of previously unseen data depends on the quality of the labels in the acoustic training dataset. Labeling large datasets is increasingly done with assistance from citizen scientists. On Manatee Chat, a citizen science project that has been running on Zooniverse.org since March 2018, 5,742 citizen scientists have labeled Zoo Tampa acoustic dataset and made 252,402 classifications. Due to the heterogeneity of manatee calls and mastication sounds’ appearance on the spectrogram, labeling such files could be challenging. Since October 2019, the standard Zooniverse.org tutorials and a field guide have been supplemented by practice and a quiz. A total of $n=521$ citizen scientists have participated in the practice and $n=447$ in the quiz (average score of 71%). The Fleiss’ Kappa (multi-raters reliability) for the Zoo Tampa
dataset was calculated for files \((n=9259)\) classified prior to the introduction of the training program, and for files \((n=5034)\) classified after it was made available. Multi-rater reliability was found to decline in with-training \((0.38)\) compared to no-training \((0.48)\) classifications. Next, 100 sound file classifications were randomly selected from no-training and with-training classification pools and rated in terms of acoustic data label accuracy by an expert. While the accuracy of acoustic labeling was slightly higher for with-training classifications \((78\%)\) compared to no-training classifications \((75\%)\), this difference was not statistically significant \((p=0.617)\). These preliminary results indicate that accurate labeling of acoustic files could be challenging for citizen scientists, and providing additional training with practice and a quiz does not necessarily significantly improve the quality of the labels in the dataset. Additional measures should be taken to improve the accuracy of acoustic data labeling done by citizen scientists.

Cranial asymmetry in Odontoceti: sound aspects to face assorted environments
Maíra Laeta¹, Salvatore Siciliano², João Oliveira³, Anders Galatius⁴
¹Museu Nacional/Universidade Federal do Rio de Janeiro, Brazil, ²Instituto Oswaldo Cruz/FIOCRUZ, ³Rio de Janeiro, Brazil, ⁴Aarhus University, Department of Bioscience, Roskilde, Denmark

Odontocetes have peculiar directional asymmetry of the facial part of the skull, a phenomenon that has been associated with sound production. In support of this, production of echolocation clicks is lateralized to the right nasal structures in species that have been investigated. We investigated consistency of asymmetry patterns across the ten odontocete families and relationships of asymmetry to aspects of sound production and habitat use. Using bi-dimensional geometric morphometrics of 335 skulls of 64 species to describe variation, average asymmetrical shape was similar across taxa showing leftward shifts of the nasal septum, frontal suture and premaxillae, followed by an enlargement of the right premaxilla and maxilla. This indicates that asymmetry is a shared derived character, serving a similar functional purpose. In contrast to this similarity, there were profound differences in asymmetry magnitude. Kogiidae, followed by Monodontidae, Globicephalinae, Physeteridae, Platanistidae and Lipotidae were the most asymmetric taxa. Other delphinids showed a wide spectrum of asymmetry, with less asymmetric taxa, (e.g., Orcininae), overlapping with Ziphiidae. Iniidae, Phocoenidae and Pontoporiidae were least asymmetric. We investigated relationships between magnitude of asymmetry and sound production with generalized linear models. Source level and maximum dive depth were the predictor variables of the best performing models \((P<0.01)\) to explain the cranial asymmetry. Thus, source level was the only feature of echolocation clicks that significantly explains the asymmetry. These results corroborate the hypothetical relationship between cranial asymmetry, powerful sound and use of deep water. An explanation may be that louder sounds may enhance foraging at depth, where larger volumes of water need to be scanned.

Use of Navy Training Ranges and NMFS’ Biologically Important Areas by Blue and Fin Whales off the U.S. West Coast
Barbara Lagerquist¹, Ladd Irvine¹, Thomas Follett¹, Erin Falcone², Gregory Schorr¹, Bruce Mate¹, Daniel M. Palacios¹
¹Oregon State University, Newport, Oregon, ²Marine Ecology and Telemetry Research, Seabeck, Washington, ³Marine Ecology & Telemetry Research, Seabeck, Washington

Blue whales arrive in the California Current System (CCS) off the United States (U.S.) West Coast in summer, while fin whales appear to remain year-round in the CCS. This study used
Argos tracks of 90 blue whales and 30 fin whales tagged from 2014 to 2017 off Southern California to examine the whales’ use of Navy training ranges and NMFS’ Biologically Important Areas (BIAs). To compute estimates of residence time inside these areas, interpolated locations were derived from the tracks at 10-min intervals, assuming a linear track and constant speed. Residence time was calculated as the sum of all 10-min segments from the interpolated tracks within each area of interest. Additionally, a Bayesian hierarchical switching state-space model was applied to the Argos locations to create a regularized track and resulting locations were used to calculate kernel home ranges (HRs) and core areas (CAs) for each track longer than 30 days. PT MUGU was the most heavily used Navy range by blue and fin whales in terms of total numbers of whales having locations there, highest residence time, and most overlapping HRs and CAs. This was followed by SOCAL, SOAR, NWTT, and area W237 of the NWTT. Of the six blue whale BIAs that overlap Navy ranges, the Santa Barbara Channel and San Miguel Island BIA appeared to be the most important area to blue whales, in terms of number of whales using the area, time spent there, and number of overlapping CAs. There were differences in Navy range and BIA use between years, likely related to different oceanographic conditions. Information from this study is valuable in the mitigation of risk to these endangered species from naval activities, in the review of existing BIAs for blue whales in the CCS, and in the development of future BIAs for fin whales.

12 Drummers Drumming: Manatee Nasal Region May Transmit Sounds
Jeffrey Laitman, Ph.D.1, Joy S. Reidenberg, Ph.D.2
1Icahn School of Medicine at Mount Sinai, 2Icahn School of Medicine at Mount Sinai, New York, New York

Manatees likely vocalize using vibrations of the vocal folds of their larynges. Although sound is generated in air, it must be transferred to water. However, the mechanism of this transmission to water is not known. We studied the anatomy of a potential site of sound transfer in the manatee nasal region. 12 West Indian (Florida) manatees (*Trichechus manatus*) specimens were examined post mortem through dissections of the head region (at MMPL, Eckerd College, FL) or examinations of dry skulls. Results were compared with over 80 genera of other mammalian specimens, including two species of the closely related elephants (*Loxodonta africana, Elephas maximus*). The nasal aperture of the manatee skull is very wide and tall. It occupies nearly 1/3 of the dorsal skull length, positioned midway between the rostral tip and foramen magnum. The aperture is covered by a pair of cartilage plates overlying the nasal cavities. Each plate is long and moderately flexible where it attaches to the skull. The cartilage is directly covered by the dorsal fat layer and thick skin. The cartilage plates end rostrally before the end of the muzzle, and the nasal passageway continues under soft tissues to the external nostrils. The skin overlying this region was noted to swell in live manatees during sound production and deflate afterwards. This implies that air is captured and recycled, thus conserving air used during vocalization. Raising cartilage plates may stretch the deep fat layer and overlying thick skin. The tightly coupled tensed skin, fat, and cartilage could then move together as one unit, essentially functioning as a drumhead. These tissues approximate water density (relative to nasal cavity air or dense skull bone), making them good candidates for a transducer. The nasal aperture coverings are proposed to transfer nasal air vibrations to water in the manner of a drumhead.

Direct reprogramming of dermal fibroblasts derived from Northern elephant seals into muscle cells
Emily Lam1, Julia Maria Torres-Velarde2, Kaitlin Allen3, Daniel Crocker4, Jose Pablo Vazquez-Medina5
1UC Berkeley, Corte Madera, CA, 2University of California, Berkeley, Torreon, Coahuila, Mexico, 3University of California Berkeley, Oakland, California, 4Sonoma State University, Rohnert Park, CA, 5University of California, Berkeley, Berkeley, California

Ex vivo tissue culture allows the study of complex cellular mechanisms that are relevant to physiological responses in animals while overcoming the challenges presented by studying animals that are not tractable. In a primary cell culture system, certain proliferating cells can be functionally reprogrammed into other cell types via overexpression of key genes. Dermal fibroblasts can be reprogrammed into muscle progenitor cells (myoblasts), which are often challenging to obtain but offer a unique system to study metabolic responses, by overexpression of the myogenic transcription factor myod. We isolated fibroblasts from Northern elephant seal (NES) skin samples and propagated them in primary culture. We overexpressed myod in NES fibroblasts and conducted antibiotic selection with 2 ug/mL puromycin for 3 days. As expected, expression of myod was significantly higher in transfected cells according to qPCR analysis (t-test p< 0.05). Treatment with small molecules (CHIR99021, Forskolin and Repsox) enhanced myod expression. Furthermore, fibroblasts overexpressing myod expressed downstream markers of myogenesis (myogenin, myosin heavy chain 1 and myosin heavy chain 8) and the effect was enhanced when myod-overexpressing cells were supplemented with small molecules. We are currently evaluating the capacity of myod-overexpressing dermal fibroblasts to differentiate into myotubes and comparing metabolic profiles with primary NES myoblasts. Establishing differentiated muscle fibers from other mature cell types could provide a unique platform to conduct mechanistic studies in species where muscle tissue samples cannot be obtained from live animals.

Fifteen years of behavioral response studies with marine mammals; what’s next?
Frans-Peter Lam1, Petter Kvadsheim2, Charlotte Curè3, Saana Isojunno4, Paul Wensveen5, Alexander von Benda-Beckmann6, Peter Tyack7, Filipa Samarra8, Patrick Miller9
1Acoustics & Sonar, TNO, The Hague, Netherlands, 2Norwegian Defence Research Establishment (FFI), NO-3191 Horten, Norway, Horten, 3Cerema Dter Est - Acoustics Group, Strasbourg cedex 2, France, 4Sea Mammal Research Unit, University of St Andrews, St Andrews, Fife, United Kingdom, 5Faculty of Life and Environmental Sciences, University of Iceland, Reykjavik, Capital Region, Iceland, 6TNO, The Hague, Zuid Holland, Netherlands, 7University of St Andrews, St Andrews, 8University of Iceland, Vestmannaeyjar, Iceland, 9Sea Mammal Research Unit, School of Biology, University of St Andrews, St Andrews, Fife, United Kingdom

The 3S-project (3S = Sea mammals & Sonar Safety) has been conducting behavioral response studies at sea for 15 years. In three phases of the project, different cetacean species and exposures to different types of sonar have been studied. With all partners of the project and for five navies (USA, NLD, NOR, UK, FRA), our goal has been to assess the nature, severity and significance of the behavioral responses to sonar exposure and to quantify thresholds and establish safe guidelines for sonar operations. Along the way we have optimized the design and the execution of our experiments for maximum data applicability. In this paper we will provide an overview of these achievements, together with the latest findings of the project. This includes the effect of new continuous active sonar (CAS) signals relative to conventional pulsed active sonar (PAS), potential masking effects, and discrimination between proximity and received level on sperm whales in northern Norway. Our
results show that responses to CAS are similar to responses to PAS, even though the Sound Pressure Level (SPL) of PAS is higher than for CAS, and as long as the Sound Exposure Level (SEL) is similar. This indicates that accumulated acoustic energy is an important driver for behavioral responses. The potential for masking is still higher for CAS, but we found little indication of actual masking of sperm whales in our data set. In northern bottlenose whales we found no effect of proximity of the source on the response threshold. Using an operational sonar source on a Norwegian naval frigate we have collected data that will allow us to also assess the effect of range on behavioral responses in sperm whales. We will also provide an outlook of future research needed to warrant the responsible use of active sonar.

Multi-year temporal acoustic analysis of minke whale pulse trains from Stanton banks, Sea of the Hebrides.

Rhiannon Lamb¹, Simon Von Sachsen-Coburg und Gotha², Ewan Edwards³, Suzanne Beck⁴, Denise Risch⁵, Per Berggren⁶
¹Newcastle University, Minehead, Somerset, United Kingdom, ²Ghent University, Ghent, Belgium, ³Marine Scotland Science, Aberdeen, Scotland, United Kingdom, ⁴Agri-Food and Biosciences Institute, Belfast, United Kingdom, ⁵Scottish Association for Marine Science, Dunbeg, United Kingdom, ⁶Newcastle University, School of Natural and Environmental Sciences, United Kingdom

Currently, acoustic information exists on common minke whales (Balaenoptera acutorostrata) from various locations throughout the North Atlantic, but detailed acoustic records from western Scottish waters has so far been missing. However, visual sightings have identified the Sea of the Hebrides and adjacent waters, as an important summer habitat for this species. One of the many threats that minke whales from this area are susceptible to, is bycatch from lobster creels. The use of passive acoustic monitoring provides fundamental information such as annual distributions, enabling effective long-term monitoring of such species. This study presents minke whale pulse train song occurrence patterns based on two years (November 2017- November 2019) of passive acoustic data from a passive acoustic recorder (SoundTrap ST300) moored at approximately 5 m above the seabed at Stanton Banks, Sea of the Hebrides. An automated pulse train detector was applied to the data to investigate seasonal and diel patterns. The results showed that minke whale pulse train occurrence was highly seasonal. Most detections were made from March to September, with 89% of detections occurring between April and August. Except for June 2018, when detections were recorded on 94% of days, detections occurred every day in May for both years and for June 2019. In each year, there were no pulse train detections during winter (November - February). Minke whale pulse trains showed evidence of a diurnal pattern, with 63% of all detections made during dark periods from 18:00 – 07:00 (GMT). These data highlight that Stanton Banks and adjacent waters are likely important habitats in the life cycle of these baleen whales. The results help to build upon existing knowledge regarding the seasonal distribution of minke whales which will help to inform conservation efforts surrounding the recently designated marine protected area for this species in the Sea of the Hebrides.

The Behavioral Activity of Humpback Whales on Their Hawaiian Breeding Grounds Measured Through Instrumented Tags

Marc Lammers¹, Jessie Kittel², Eden Zang³, Julia Zeh⁴, Susan E Parks⁵, William Gough⁶, David Cade⁷, Edward Lyman⁸, Adam Pack⁹
¹Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, Hawaii, ²National Marine Sanctuary Foundation, Silver Spring, MD, ³Hawaiian Islands Humpback Whale
The Hawaiian Islands are the principal breeding habitat for north Pacific humpback whales (*Megaptera novaeangliae*). While in Hawaii, humpback whales engage in a variety of breeding behaviors such as giving birth, nursing their young, competing for mates and performing displays. These activities are conducted while fasting and relying on stored energy resources accumulated while feeding at higher latitudes during the summer. How humpback whales manage those resources by regulating their activities while on the breeding grounds remains poorly understood. For instance, little is still known about how whales balance periods of high-energy behaviors with rest and even how daytime activity levels compare to those at night. To explore these questions, whale behavior was quantified through the use of temporarily attached suction cup tags equipped with accelerometer, magnetometer and depth sensors that allow a whale’s fine scale movements to be logged for multiple hours. Between 2018 and 2021 a total of 32 whales were tagged using either Acousonde, Dtag or CATS tags. Tag deployment durations ranged from less than one hour to 46.5 hours with a median duration of 4.3 hours. Dive duration, breathing rate, fluke stroke rate and overall dynamic body acceleration (ODBA) were used as proxy metrics for whale activity. These metrics were then used to examine temporal patterns of activity among whales in different social roles. Results indicate that whale behavior alternates between periods of elevated activity and periods of apparent energy conservation. Moreover, these periods tend to follow predictable temporal patterns, with lower activity levels prevalent during mid-day hours. These findings are relevant to the management and conservation of humpback whales on their Hawaiian breeding grounds where they are the focus of intense public and commercial whale watching activities. A better understanding of whales’ natural behavioral cycles could lead to more effective viewing guidelines.

**Dietary niche breadth and overlap between Arctic and northward range-shifting sub-Arctic marine mammals in Greenland**

Haley Land-Miller¹, Anna Roos², Sara Pedro³, Malene Simon⁴, Rune Dietz⁵, Christian Sonne⁵, Aqqalu Rosing-Asvid⁶, Melissa McKinney⁷

¹McGill University, Sainte Anne de Bellevue, Quebec, ²Greenland Institute of Natural Resources, ³Department of Social and Preventive Medicine, Université Laval, Quebec City, QC, ⁴Nuuk, Greenland, Greenland, ⁵Aarhus University, Roskilde, Denmark, ⁶Nuuk, Greenland, Denmark, ⁷McGill University, Ste-Anne-de-Bellevue, QC

Climate change has induced range shifts of multiple historically sub-Arctic marine mammals northward into the Arctic. In Greenland, these shifts have introduced novel or increased areas of geographic and temporal overlap with native Arctic seals and cetaceans, creating the potential for competitive feeding interactions. Using fatty acids and stable isotopes of carbon, nitrogen, and sulfur as dietary tracers, we used Bayesian estimates of probabilistic niche regions to model niche breadth and overlap of 230 individuals representing nine marine mammal species collected in Greenland from 2011 to 2018. The Arctic species were ringed seal, bearded seal, and narwhal; the sub-Arctic species were humpback whale, minke whale, long-finned pilot whale, white-beaked dolphin, harp/hooded seal (grouped), and harbor porpoise. Bayesian ellipses calculated from the fourteen most abundant diet-derived fatty acids demonstrate that the native Arctic marine mammal species on average
occupy narrower feeding niches than the sub-Arctic species, with the two sub-Arctic baleen whales, humpback and minke whales, having both the widest niches and highest mean overlap of other species. Of the three native Arctic species, narwhal overlap highly by both humpback and minke whales (84 and 99%, respectively) and moderately by long-finned pilot whales, harbor porpoise, and harp/hooded seals (24, 28, and 35%). Ringed seals overlap moderately by minke whales, harp/hooded seals and humpback whales (24, 41 and 46%), and bearded seals overlap only by minke whales (55%). Parallel stable isotope data is being generated. Although results could, in part, be influenced by collections from multiple locations around Greenland, and uncertainty remains about specific diet compositions, these initial findings suggest strong potential for competitive feeding interactions between some native Arctic and range-shifting sub-Arctic marine mammal species. This degree of dietary niche overlap could have significant implications for the fate of vulnerable native species already facing multiple threats in a rapidly changing Arctic.

**Prevalence and Genotype of Toxoplasma gondii in Stranded Hawaiian Cetaceans**

Nelmarie Landrau-Giovannetti¹, Thomas B. Waltzek², Chunlei Su³, David Rotstein¹, Gregg Levine³, Ilse Silva-Krott⁴, Kristi West⁷

¹University of Florida, Gainesville, FL, ²University of Florida, ³University of Tennessee, ⁴Marine Mammal Pathology Services, Olney, Maryland, ⁵Dolphin Quest, ⁶Honolulu, HI, ⁷University of Hawaii, Kaneohe Bay, HI

Toxoplasma gondii is a significant protozoal disease threat to endangered Hawaiian birds and marine mammals. To estimate the prevalence of T. gondii from 1997-2019 in Hawaiian cetaceans, we tested tissues from 26 stranded spinner dolphins (Stenella longirostris) and 29 stranded individuals representing 15 cetacean species. DNA from tissue extracts was screened by nested PCR assay targeting the Toxoplasmatinae internal transcribed spacer 1 of the nuclear ribosomal DNA. Of 312 tissue samples tested, two spinner dolphins were positive in all tissues. One spinner dolphin was an adult male that stranded on Hawai‘i Island in 2015 and the other was a calf stranded on the island of Oah‘u in 2019 suggestive of vertical transmission. The PCR positive spinner dolphins had correlative microscopic lesions including myocarditis with extracellular and intracellular protozoal cysts and tachyzoites, necrotizing lesions in the brain with protozoal cysts and bronchointerstitial pneumonia with intra-endothelial tachyzoites. Discrete positive immunohistochemistry staining for T. gondii was observed in adrenal gland, brain, liver and lung. PCR-RFLP analysis of ten genetic markers revealed the ToxoDB genotype #24, recently described from feral swine (Sus scrofa) in Hawai‘i whereas different Toxoplasma genotypes were found in studies of monk seals, Hawaiian goose and crow. These cases represent the first report of Toxoplasma genotypes in cetaceans in Hawai‘i and are the second and third reports of disseminated T. gondii infection in stranded spinner dolphins in the last 30 years. When using low carcass recovery rates in Hawai‘i for spinner dolphins to extrapolate these findings, T. gondii is likely responsible for at least 60 spinner dolphin deaths in Hawaiian waters over the past three decades. Nearshore species, like Hawaiian spinner dolphins, may be at increased risk from this parasite in marine coastal waterways via sewage systems, storm water drainage and freshwater runoff.

**Overlap of Humpback Whale (Megaptera novaeangliae) Habitat and Vessel Traffic in San Francisco Bay with Insights from Tagging**

Bekah Lane¹, James Fahlbusch², John Calambokidis³, Allison Payne⁴, Thomas Moore⁵, Bill Keener⁶, Isidore Szczepaniak⁷, Tim M Markowitz³, Marc Webber⁴, Ellen Hines⁹

¹The Marine Mammal Center, ²Stanford University, Cascadia Research Collective,
Since 2016, humpback whales (Megaptera novaeangliae) have regularly been observed in San Francisco Bay (SF Bay) and the Golden Gate Strait (GGS) from April to November. The conservation status of humpback whale populations feeding in this area combined with dense vessel traffic emphasizes the need for research on the risk of vessel strikes. Mortality by ship strike is estimated to be twice the federal limit along the California coast, but ship strike risk has not been assessed in SF Bay. We collected 184 humpback whale sightings and compared them against vessel data from Automatic Identification Systems (AIS) for 2017. Our research represents habitat use of three tagged humpback whales from a single day in relation to AIS-carrying vessels. On 23 July 2017, Cascadia Research Collective personnel tagged three humpback whales in SF Bay using suction-cup attached, multi-sensor tags. Tagged individuals spent an average of 56% of time tagged at less than 15 m depth and 27.7% of time tagged in shipping lanes. Vessels in the study area drafted between 1.3 and 17.5 m, indicating the potential for three-dimensional overlap between whales and large ships. We plan to use sightings data to further evaluate degree of spatiotemporal overlap between vessels and whales throughout 2017. Our data show the three-dimensional overlap between whale habitat use and vessel traffic in the GGS and SF Bay. This application of tagging in combination with the use of AIS data is a viable method to quantify the potential risk of ship strikes to baleen whales in SF Bay and beyond.
that Odontoceti and Mysticeti have distinct allometric trajectories, with baleen whales displaying a decelerated growth relative to toothed whales. Odontoceti present significant differences in allometric trajectory among families with different skull morphologies, which persist even after taking phylogeny into account. This shows the profound influence of developmental changes in the evolution of the disparate feeding adaptions present in modern Cetacea.

**Generalizing drone-based neural network monitoring for populations of grey seals (Halichoerus grypus) across colonies in the Northwest Atlantic**

**Gregory Larsen**¹, Candice Sheehan², Patrick Gray³, Madeline Hayes⁴, Julian Dale⁵, Alexander Seymour⁶, Arnaud Mosnier⁶, David Johnston⁷

¹Duke University, Beaufort, North Carolina, ²Duke University Marine Lab, BEAUFORT, NC, ³Duke University, Durham, NC, ⁴Duke University Marine Laboratory, Beaufort, North Carolina, ⁵Duke University Marine Lab, ⁶Fisheries and Oceans Canada, Mont-Joli, ⁷Division of Marine Science and Conservation, Nicholas School of the Environment, Duke University Marine Laboratory, Beaufort, North Carolina

Remote sensing techniques enable wildlife research and monitoring at new scales of coverage and precision, with high safety, low barriers to access, and minimal disturbance to target and incidental species. Remote sensing tools, however, shift research bottlenecks from data collection to data analysis, and many strategies have emerged to better handle ‘big data’ in population monitoring and management. Machine learning techniques are increasingly applied in marine mammal studies, but often as proof-of-concept examples alongside conventional visual analysis and limited to subsets of a single-source dataset for both model training and evaluation. In this study, we trained and tested RetinaNet convolutional neural network models on drone imagery from seven colony surveys of grey seals (*Halichoerus grypus*) including adult and pup life stages. Imagery was collected from rookeries on Hay, Pictou, Saddle and Muskeget islands in the Northwest Atlantic at various points in the breeding season, with diverse contextual conditions with respect to lighting, background substrates, UAS sensors, and ground-sample distances. Our analysis demonstrates an open-source implementation and quantifies differences in model performances across different survey conditions. We quantify how (1) single-survey training data and (2) diversified multiple-survey training data yield models that perform differently across colony surveys, and we distinguish conditions that lead to misclassification within and across datasets. These findings critically inform how machine learning techniques can be generalized for regular deployment in population research and monitoring programs, highlighting current limitations and opportunities to complement and facilitate conventional image analysis methods.

**Adapting management with a changing climate—new insights on monitoring reproduction in Pacific walruses**

**Jenell Larsen Tempel**¹, Shannon Atkinson DeMaster¹

¹University of Alaska Fairbanks

Historically, reproductive rates of Pacific walruses (*Odobenus rosmarus divergens*) in Alaska were determined from analyzing the reproductive tracts of females harvested in Native Alaska spring subsistence hunts. In recent decades, the number of animals hunted in the Bering Strait region of Alaska has decreased significantly, limiting the number of full reproductive tracts collected. In this study, we investigated 1) why harvests have decreased in the Bering Strait and 2) if new approaches could be used to better monitor walrus reproduction. Results from interviews with local community
members in two Bering Strait villages indicated that lack of sea ice and increasing storms has limited hunters’ ability to harvest walruses, and that seasonality patterns have changed, with less reliability on the traditional spring harvest. Using reproductive tracts collected from female walruses (n = 13) hunted in spring subsistence hunts by Alaska Native communities, we assessed if an endocrine approach could be used to determine reproductive states of female walruses. Ovarian tissue samples were analyzed for hormone profiles and females were categorized as postpartum, pregnant or unbred. Total estrogen concentrations were greatest in unbred (n = 2) and pregnant (n = 2) females. Progesterone concentrations were also greater in unbred (n = 2) than pregnant (n = 2) and postpartum (n = 9) animals. Both unbred animals in the study were in a state of pseudopregnancy, which has not been physiologically described for this species before. An endocrine approach may be a valuable tool for determining reproductive status of females, however to accurately determine pregnant versus pseudopregnant individuals, sampling should occur in fall/winter months. Given that hunters are now reporting harvesting walruses throughout the year, we recommend that managers partner with local community members and create a flexible sampling regime to develop more accurate endocrine methods for determining pregnancy rates.

Timing Of The Sea Otter, Enhydra Lutris, Population Bottleneck Resulting In Low Range Wide Genetic Diversity
Shawn Larson¹, Erick Gagne¹, Raphael Leblois²
¹Seattle Aquarium, Seattle, WA, ²Institut de Biologie Computationnelle, Univ. Montpellier, Montpellier, France

Sea otter, Enhydra lutris, populations were known to be decimated by the maritime fur trade. Between the start of the fur trade in 1741 and 1910 when they were eventually afforded protection sea otter lost an estimated 99% of their population resulting on 11 scattered populations throughout the range numbering between 10 and 100 remnants. Thus it remains a popular theory that the population bottleneck from the fur trade was responsible for the low genetic diversity found in extant sea otters today. However several recent studies have indicated that the fur trade extirpations may not be the only significant population bottleneck sea otters have experienced. To determine the timing of the significant population bottleneck in sea otters over 300 sea otters tissue samples collected range wide from both remnant populations (N=5) and translocated populations (N=3) were analyzed for significant genetic contractions. Samples were analyzed using 19 microsatellite nuclear loci and Migraine genetics software to determine timing of the bottleneck. The best estimate for the timing of the bottleneck in the remnant populations was approximately 2000 years before present (ybp) with the range being 222 to 10,160 ybp. The best estimate for the timing of the bottleneck in the translocated populations was 1130 ybp with the range being 30 to 5960 ybp. The lower estimate for the remnant populations fits within the height of the fur trade while the lower estimate for the translocated fits within the start of the populations growth after translocations thus these are easy to explain. While the earlier estimated timings of the bottlenecks 2000 to 10,000 ybp suggest other explanations from first nations management to the last ice age to earthquakes to climate change. There remain many hypotheses to explore given the range of possible results from this analysis.

Preliminary Documentation of Skin Lesions on Bottlenose Dolphins, Tursiops truncatus, off Cape May, New Jersey
Melissa Laurino¹, Michael Denk², Alayna Robertson³
¹Cape May Whale Watch and Research Center, Stockton University, Cape May, New Jersey, ²Woods Hole Oceanographic Institution (Guest
Bottlenose dolphins, Tursiops truncatus, are excellent sentinels of ecosystem and ultimately human health, as they bioaccumulate toxins and lipophilic pollutants from prey and the environment. Skin lesions observed in these animals may result from a variety of infectious causes as well as trauma. Assessment of the prevalence and nature of these lesions is important, as their underlying pathogenesis may be related to immune compromise via environmental degradation. No vessel-based studies to date have systematically documented skin lesions in bottlenose dolphins sighted off the coast of New Jersey. Photo-identification data of a semi-residential population of free-ranging bottlenose dolphins in Cape May, NJ was collected by the Cape May Whale Watch & Research Center from April to November 2019. Photos from this date range were visually screened for skin lesions and grouped by lesion appearance and photo quality. One or more categories of skin lesions were observed in 77% (n=403) of group sightings, with 53% (n=274) of these groups exhibiting at least two types of lesions. Thirteen categories of skin lesions were documented, with dark fringe, white fringe, and tattoo lesions being the three most prevalent types in this data set. Monitoring distinct lesions on catalogued individuals over time will assist in understanding the progression or regression of certain lesion types. Continued understanding of skin lesion occurrence in this population may further assist our knowledge of disease susceptibility and ecosystem health for future conservation efforts.

Impact of Covid-19 on acoustic habitat, vessel activity, and humpback whale calling behavior on an Icelandic foraging ground

Amelie Laute¹, Thomas Grove², Marianne Helene Rasmussen³, Adam Smith⁴, Olli Loisa⁵, Michelle E.H. Fournet⁶

¹Whale Wise, Kiel, Schleswig-Holstein, Germany, ²University of Edinburgh, Edinburgh, United Kingdom, ³Húsavík Research Center, University of Iceland, Húsavík, ⁴University of Southern Denmark, Denmark, ⁵Turku University of Applied Sciences, Turku, Finland, ⁶Sound Science Research Collective

The Covid-19 pandemic provided an unprecedented opportunity to study the contribution of anthropogenic noise to the natural soundscape as well as the acoustic response of marine mammals towards noise. In this study, we used acoustic recordings, visual observations, and AIS (Automatic Identification System) data to determine the impact of Covid-19 on a foraging ground of humpback whales (Megaptera novaeangliae) in Skjálfandi Bay, Iceland. We compared pre-pandemic (2018) with pandemic (2020) conditions to quantify the reduction in vessel activity and determine the impact on the soundscape and calling behavior. The soundscape of Skjálfandi Bay was relatively quiet in both years (~ 90 dB_{RMS} (25-1300 Hz) re 1 µPa). Primary drivers were geophysical sources of sound and vessels. Humpback whale calls were detected throughout the day. During the Covid-19 pandemic in 2020 the number of whale-watching trips was reduced by two-thirds. The number of humpback whale call detections increased nearly two-fold. Median daily noise levels did not change significantly between 2018 and 2020. Modelling results further indicate that humpback whales reduce their calling effort in the presence of vessels independent of the overall ambient noise. As vessel traffic rebounds and continues to grow, demonstrating behavioral responses should inform management plans such as vessel codes of conduct and marine spatial planning.
New VisualSurveyor Software and Digital Geometers Combine To Provide Significant Advantages For Visual Surveyors

Jack Lawson¹, Pierre Goulet², Baldur Þorgíslsson³
¹Fisheries and Oceans Canada, St. John's, Newfoundland, ²Fisheries and Oceans Canada, St. John's, Newfoundland, ³NAMMCO, Tromsø, Norway

Visual surveys by aircraft, vessels, or other vehicles are an important means to assess the distribution and abundance of marine mammals. It can be difficult to record and manage sightings data, and later error-check and export these data for analysis. Over the years there have been a limited number of survey programs created to address these problems, and they have had limited feature sets. To address the potential needs of a broad variety of users, Fisheries and Oceans Canada funded creation of a new program called “VisualSurveyor” (VS) to perform real-time data recording, entry, navigation, and data output tasks with a unified interface. This software is an integrated tool to enter data during the survey, and post-process and extract basic information from these survey data. VisualSurveyor runs on 64-bit Windows computers (v. 7 and 10) and accepts input from devices like Pi Geometers, USB buttons, keyboards, and GPS, and is very resistant to data loss. A new device for declination measurement, the electronic Geometer by Pi Technology, is beneficial for VS as it speeds data collection and reduces observer error in determining the time and declination of a sighting. Data is maintained in a single local SQLite database; VS was designed to be operable from a single folder containing all program components. The program configurations, and recorded data, are stored in a relational database in a way that is robust to PC failure, with customizable data output via Structured Query Language scripts. An error checker will ensure data entered by keyboard is within the scope of data choices (e.g., only accepted species codes) as different surveys will require different choices. In the future, VS will be able to record data from other devices (e.g., microphone audio files) and link them to the relevant sighting.

Examining the impacts of pinnipeds on Atlantic Salmon: The effects of river restoration on predator-prey interactions

Lauri Leach¹, Mitch Simpson², Justin Stevens³, Kristina Cammen⁴
¹University of Maine; Marine Mammal Commission, Silver Spring, MD, ²Maine Department of Marine Resources, Bangor, Maine, ³Maine Sea Grant, University of Maine, Orono, Maine, ⁴University of Maine, Orono, Maine

Seal populations in the Gulf of Maine have been recovering from historical bounty-driven declines since they received federal protection in 1972. In the past few decades, their population growth has sparked renewed concerns over conflict between pinniped and fish conservation. In the Penobscot River in Maine, United States, where restoration efforts over the past decade have aimed at restoring diadromous fish runs, seal predation on the endangered Atlantic Salmon (Salmo salar) has become a growing concern. Quantitative and qualitative data for individual salmon, as well as the presence of putative seal-induced injury, have been collected from salmon passing upriver at dams in the Penobscot River since 2012. An analysis of seal-induced injury rate with demographic data, river herring returns, estuary fish biomass estimates, and timing of peak estuary fish biomass revealed that the seal-induced injury rate declined in the Penobscot River from 2012 to 2019, coincident with increasing river herring returns and estuary fish biomass. Despite a potentially increasing seal population, these results suggest that prey buffering from increasing forage fish may provide protection to salmon against seal predation. The presence of multiple injuries on an individual salmon was also significantly associated with the probability of a salmon
having a seal-induced injury. Lamprey wounds and lacerations on salmon were commonly associated with seal-induced injury, suggesting a confounding effect of multiple stressors. This assessment illustrates how multi-species diadromous restoration activities may alter predator-prey interactions in ways that support salmon conservation efforts. As demonstrated in the Penobscot, a focus on overall ecosystem health and restoration can benefit multiple species that use the river. Insights from this study may help inform future management decisions in other human-impacted systems where protected predators come into conflict with endangered prey.

**Seasonal differences in school composition of long-beaked common dolphins (D. d. bairdii) off Southern California**

**Sam Leander**¹, John Durban², Holly Fearnbach¹, Trevor Joyce⁴, Frederick (Eric) Archer⁵, Brandon Southall⁶, Kerri Danil⁷, Lisa T. Ballance⁸

¹Southall Environmental Associates, San Diego, CA, ²Oregon State University, ³SR3, SeaLife Response, Rehabilitation and Research, Seattle, WA, ⁴Environmental Assessment Services, Inc. affiliated with NOAA Southwest Fisheries Science Center, La Jolla, CA, ⁵Southwest Fisheries Science Center, La Jolla, California, ⁶Southwell Environmental Associates, Inc., Apts, California, ⁷NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California, ⁸Oregon State University, Newport, Oregon

Eastern North Pacific long-beaked common dolphins (*Delphinus delphis bairdii*) often form large, energetic schools that make characterization of school composition difficult. Here we demonstrate how drones can be used to obtain precise measurements of individual *D. d. bairdii*. Additionally, we apply the recently identified sexually dimorphic measurements of the subspecies (specifically “posterior” length, or the length from the anterior insertion of the dorsal fin to fluke notch) to distinguish adult males of a large size class from visually similar adult females. Using aerial images from eight schools of *D. d. bairdii* collected during June and October (2017-2019), we obtained total length estimates of 693 dolphins and posterior length estimates of 768 dolphins in waters off Southern California. In June, measured dolphins were on average 7-8cm longer in both total and posterior length. In addition, there were proportionally fewer calves and more large adult males measured during June compared to October. In a Bayesian mixture model, two June schools were best described by a size distribution cluster with a higher proportion of large individuals than the cluster that best described all October schools and two of four June schools, which had a higher proportion of small individuals. Our results suggest that some schools sampled in June have a different composition than the other six sampled schools, and likely represent either “bachelor” groups, consisting of all males, or reproductive schools, in which adult females are also present. Insights into school composition can provide a means to understand basic biology and ecology, including reproductive patterns. They can also be applied to conservation assessments, allowing better understanding of the potentially differential vulnerability of demographic groups to natural or anthropogenic disturbances.

**Stranding events and mortality of the West Indian manatee (Trichechus manatus) in Ceará State, northeastern Brazil, from 2003 to 2020**

**Cinthya Leite de Oliveira**¹, Vitor Luz Carvalho², Leticia Gonçalves Pereira³, Cristine Pereira Negrão Silva⁴, Diego Pinheiro⁵

¹Aquasis, ²Associação de Pesquisa e Preservação de Ecossistemas Aquáticos, Fortaleza, Ceará, Brazil

The West Indian manatee (*Trichechus manatus*) is considered endangered in Brazil, with low population estimate in the country. Strandings of
newborns are a known threat to the recovery of the species, especially on the semiarid coast. This work aims to analyze the stranding and mortality events of manatees in the State of Ceará, Brazil, from 2003 to 2020. A retrospective study of reports of stranded individuals was carried out. There were 74 events, 58.1% (43/74) live and 41.8% (31/74) dead animals. The annual average was 4.1 strandings, with a tendency of increasing in the last five years. Sex distribution was male (32), female (35) and indeterminated (7). Newborns and calves represented 85.1% (63/74) of the records, most of them rescued alive (42). About the stranded dead animals (31) and individuals that died during rescues, in rehabilitation or after release (14), *causa mortis* was undetermined or not reported to 42.3% (19/45); natural to 40% (18/45), including septicemia, drowning/asphyxia, malnutrition, malformations and cardiac arrest; and anthropogenic to 17.7% (8/45), including bycatch, vessel collision and a case of gunshot. The highest number of strandings (95.9%) occurred on the east coast of Ceará, an area with a large rate of manatee occurrence. The high number of stranded newborns observed may be a consequence of births outside the natural habitat caused by environmental changes or direct anthropogenic actions, plus the lack of maternal ability with its calves. Ceará state has the highest stranding numbers in Brazil and there was a considerable increase in the frequency of dead animals, mainly calves, in relation to the records from the late 1980s to the early 2000s. These studies are important to outline strategies for the conservation of sirenians in the state of Ceará.

**Gray whale body condition assessment: photo scoring or drone-based photogrammetry?**  
**Leila Lemos**, **Derek Garcia**, **Leigh Torres**  
1Florida International University, Brazil, 2Marine Mammal Institute, Oregon State University, Newport, Oregon

Reliable assessment of baleen whale body condition is important to monitor health and physiological response to environmental change and disturbance events. Therefore, determining logistically feasible and accurate methods for whale body condition assessment is critical. Two different methods to quantify body condition in gray whales have been applied recently: qualitative scoring of oblique traditional photographs and photogrammetry methods using vertical drone-captured images. We simultaneously collected photographs and drone images of gray whales on their foraging ground in Oregon, USA, during the summers of 2016-2018 to assess the correspondence between body condition assessment methods. Additionally, we compared the correlation of these two methods to fecal cortisol concentrations derived from the same whales to determine the degree of resolution needed to resolve physiological patterns. Concurrent photographs and drone images were collected at 274 sightings of 106 individual whales, and 42 fecal samples were collected and analyzed for cortisol concentrations. Photographs were qualitatively scored by one consistent evaluator as poor, fair, and good based on the relative amount of subcutaneous fat in three body regions: postcranial area, scapular region, and lateral flanks. A series of whale body length and width measurements were made in each drone image, which integrated to produce the Body Area Index (BAI) metric that quantifies the relative body condition for each whale. The two methods were positively correlated (one-way ANOVA: $F_{2,250} = 15.66$, $p < 0.001$), indicating good correspondence. However, when comparing each method with fecal cortisol concentrations, only BAI resulted in a significant correlation (linear regression: $F_{1,40} = 8.301$, $p < 0.01$): skinnier whales had higher cortisol concentrations. Our findings suggest that both photograph scoring and drone image photogrammetry can provide reliable assessments of gray whale body condition, yet the quantitative measurements derived from drone-based photogrammetry enable more resolved
data that can allow effective comparison to other factors.

The IWC at 75: evolution in an ever-changing environment
Rebecca Lent¹, Iain Staniland², Kate Wilson³
¹International Whaling Commission, United Kingdom, ²International Whaling Commission, Cambridge, United Kingdom, ³International Whaling Commission, Impington-Cambridge, Others, United Kingdom

This year marks the 75th anniversary of the International Whaling Commission. Established in 1946, the IWC has grown from a membership of 15 to 88 governments. Whilst the mandate of the organisation remains unchanged the threats to whales are now very different. It is a reflection of the IWC’s adaptability that the Commission is as relevant today as it was in 1946. The IWC story is one of continuous evolution in an ever-changing environment. The science and stewardship programme currently undertaken by the IWC reflects the breadth and scale of threats to cetaceans in the 21st century. IWC’s Bycatch Mitigation Initiative addresses the greatest single threat to cetaceans through collaborative work with the fishery sector to achieve practical and viable solutions. Several pilot projects are being launched with a particular focus on building capacity in small-scale coastal gillnet fleets to address cetacean bycatch. Ship strikes, ocean noise, marine debris, chemical pollution and climate change are other human-induced threats that have increased significantly since IWC was formed. The IWC provides scientific evidence of how these threats impact cetacean stocks and works with stakeholders at every level to raise awareness and find workable solutions. For example, IWC scientific work on underwater noise provided the information needed by the International Maritime Organisation to develop noise-reduction proposals. The IWC’s Stranding Initiative is overseen by an Expert Panel that can respond quickly and effectively to cetacean stranding events, with the objective of collating key information to better understand and manage the underlying causes. The important IWC responsibility of managing aboriginal subsistence whaling ensures that traditional hunts in four indigenous regions continue to meet cultural and nutritional needs, whilst rigorous scientific scrutiny safeguards the long-term viability of the target populations.

Vulnerability of U.S. Marine Mammal Stocks in the Pacific and Arctic to Climate Change
Matthew Lettrich¹, Jason Baker², Dorothy Dick¹, Christina Fahy³, Paul Fiedler¹, Nancy Friday⁴, Krista Graham, Roger Griffiss⁵, Dawn Noren⁶, Peter Thomas⁷, Sadie Wright⁸, Robin Baird⁹, Lisa T. Ballance¹⁰, Lars Bejder¹¹, Steven J. Bograd¹², Charlotte Boyd¹³, Amanda Bradford¹⁴, Lauren Divine¹⁵, Candice Emmons¹⁶, Brian Fadely¹⁷, Erin Falcone¹⁸, Megan Ferguson¹⁹, Donna Hauser²⁰, Elliott L. Hazen²¹, Jaime Jahncke²², Steven Jeffries²³, Michelle Lander²⁴, Charles Littnan²⁵, Josh London²⁶, Lisa Loseto²⁷, Sharon Melin²⁸, Daniel Monson²⁹, John Moran³⁰, Erin Oleson³¹, Heidi Pearson³², Lori Quakenbush³³, Kimberly Raum-Suryan³⁴, Jan Roletto³⁵, Brenda Rone³⁶, Gregory Schorr³⁷, Jonathan Scordino³⁸, Kim Shelden³⁹, Sheanna Steingass⁴⁰, Jeremy Sterling⁴¹, Raphaela STIMMELMAYR⁴², Suzie Teerlink⁴³, (Martin) Tim Tinker⁴⁴, David Weller⁴⁵, Michael Williams⁴⁶, Alexandre Zerbini⁴⁷, Diane Bowen⁴⁸, Lilian Carswell⁴⁹, Deanna Lynch⁵⁰, ECS Federal, Inc. in support of NOAA Fisheries, ²Protected Species Division / NOAA / PIFSC, Honolulu, HI, ³Ocean Associates Inc. under contract for NOAA Fisheries Office of Protected Resources, Silver Spring, MD, ⁴National Marine Fisheries Service, Long Beach, California, ⁵NOAA Southwest Fisheries Science Center, La Jolla, California, ⁶Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, Washington, ⁷NOAA Fisheries, ⁸Pacific Islands Regional Office, Kailua, HI, ⁹NOAA Fisheries Office of Science and Technology,
Climate change presents additional challenges to the management and conservation of marine mammal species that are already experiencing a multitude of cumulative anthropogenic stressors. A climate vulnerability assessment is a systematic approach for determining potential climate change effects on species, including marine mammals. This approach can identify vulnerable species and stocks and provide insights into climate-related drivers of vulnerability to inform management and decision-making. We employed expert elicitation in a trait-based climate vulnerability assessment framework to characterize the vulnerability of U.S. marine mammal stocks in the Pacific and Arctic ecosystems. Forty-two marine mammal experts scored climate exposure (projected changes in climate and ocean conditions within the current stock distribution compared with historical conditions) and climate sensitivity (using life history characteristics as proxies) for 129 U.S. marine mammal stocks or stock groups. Exposure and sensitivity scores were combined to calculate a climate vulnerability index. Results indicate that most stocks (70%) have very high exposure to climate change, 27%
high exposure, 2% moderate exposure, and no stocks have low exposure. Few stocks (7%) have very high sensitivity to climate change, while 36% have high sensitivity, 48% moderate sensitivity, and 9% low sensitivity. The resulting climate vulnerability score is very high for 30% of stocks, high for 50%, moderate for 16%, and low for 3%. Similar to vulnerability assessments for other marine species, ocean pH, sea surface temperature, and dissolved oxygen were the primary drivers of high climate exposure scores, through direct and indirect effects (e.g., prey reductions). Non-migratory behavior and high site fidelity were primary drivers of high climate sensitivity scores. This assessment quantified the vulnerability of Pacific and Arctic marine mammals to climate change and will facilitate more precise and strategic research, conservation, and management activities for highly vulnerable species and stocks.

**Morphological revision and molecular characterization of helminths in the respiratory tract of the Indo-Pacific finless porpoises in Hong Kong waters**

*Edgar Kwan Chak Leung,* Brian Chin Wing Kot*, Tabris Yik To Chung*, Priscilla To Yan Leung*

*1City University of Hong Kong, Hong Kong, China, 2City University of Hong Kong, Hong Kong*

*Halocercus* spp. are parasites predilected in cetaceans’ respiratory tract, with scarce information on their identity, and their severity, distribution and life cycle remain unknown. With the often advanced decomposition of specimens, helminths commonly found in the respiratory tract of the Indo-Pacific finless porpoises stranded in Hong Kong waters were only proposed to be *H. pingi* by morphological identification. In this study, *Halocercus* species recovered from the respiratory tracts of 29 Indo-Pacific finless porpoise (unweaned: n=5; weaned: n=24) stranded in Hong Kong waters in 2020-2021 were investigated. Helminths were found in 6 cases (21%) and comprehensively characterized by both morphological and molecular methods. Two nematode species were morphologically identified from intact specimens: *H. pingi* and *H. sunameri.* Morphological features and morphometrics for species-specific identification were documented and illustrated. DNA Sequences of *COI* and *ITS-2* genes of the helminths were analysed using phylogenetic relationships among the genus *Halocercus.* Two major clusters were resolved, which were in accordance with the morphological identification. Decomposed fragments, which were unable to be identified by morphology, were successfully identified by the molecular approach. Among these 6 infected cases, the 2 unweaned calves’ tracheae (40%, 2/5) were infected by free *H. pingi,* and the 4 weaned animals’ lungs (17%, 4/24) showed granulomatous infection by *H. sunameri.* This is the first report of *H. sunameri* infection in Indo-Pacific finless porpoise, which not only advances the morphology and molecular database of helminths in cetaceans, but also provides insights into its influence on host life stages, predilection sites and pathology.

**Female social responses to the risk of male sexual harassment vary by habitat in bottlenose dolphins**

*Alexis Levengood*, Janet Mann*, Vivienne Foroughirad*, Ewa Krzyszczyk*, Céline Frère*

*1University of the Sunshine Coast, East Stroudsburg, Pennsylvania, 2Georgetown University, Washington, DC, 3Georgetown University, MOREHEAD CITY, North Carolina, 4Georgetown university, WASHINGTON, DISTRICT OF COLUMBIA, 5University of the Sunshine Coast, Sippy Downs, Queensland, Australia*

Sexual conflict over divergent reproductive strategies is ubiquitous across sexually reproducing species. At the core of this conflict
lies adaptive male strategies, such as sexual harassment, to overcome female resistance to mating and female strategies to minimize the associated costs. Among group living species, short-term strategies such as, spatial segregation, fleeing, and allied support are well-documented female social strategies. However, commonly overlooked are long-term strategies (such as long-term social avoidances to avoid the risk of male sexual harassment altogether) and the role that habitat use may play in these types of tactics. Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) are a compelling system for investigating such strategies of females because male dolphins form long-term sexually coercive alliances, females form long-term bonds, and both sexes demonstrate social avoidances and occupy highly heterogenous habitats. Here, we use 30+ years of behavioral observations of bottlenose dolphins (*N* = 191) in Shark Bay, Australia to investigate the long-term social strategies that females use to minimize the risk of male sexual harassment and how these vary by habitat. We show that females utilize different social strategies depending on both their preferred habitat and their perceived risk of male sexual harassment. Specifically, when the sex ratio was male biased, females utilizing deep open waters increased long-term intersexual social preferences and avoidances, while decreasing their casual (i.e., random, weaker) associations. In contrast, females who preferentially used shallow and channel habitats increased intrasexual casual associations when the sex ratio was male biased. Our results emphasize that male sexual harassment is a significant driver of female social behavior and extend previous research by highlighting the effect of habitat on the use of long-term female social strategies to reduce the risk of male sexual harassment.

---

**Northern fur seal (Callorhinus ursinus)**

**northward homing movements response to oceanographic features**

**Heping Li¹, Yoko Mitani²**

¹Kyoto University, Hakodate, Japan, ²Kyoto University, Hokkaido, Japan

Oceanographic features provide an insight into the quality of feeding grounds, which influence body conditions and behaviors of migratory species. Northern fur seals (NFS) establish a southward migration after the breeding season and overwinter in the North Pacific Ocean. Migration helps them to get access to prey which is vast, predictable but seasonal. In the non-breeding season, NFS are often observed at sea around Japan, where provide feeding grounds for seals from various breeding sites. Previous studies illustrated interactions between oceanographic features and southward migration; however, how their northward migration responds to the encountered environments is unknown. To describe NFS northward homing movements and to examine the relationship between their behaviors and oceanic features, we deployed satellite transmitters (SPOT 6; Wildlife Computers, USA) to five individuals from February to June in 2017, 2019, and 2020 off Matsumae, the Sea of Japan coast of Hokkaido, Japan. A state-space switching approach was used to determine behaviors into transit and restricted modes, then, compared with static and dynamic variables such as water depth and sea surface height were prepared. Mesoscale eddies were detected and the distance from NFS to closest eddies was calculated. Tracked NFS firstly moved eastward to the Pacific water of Japan and meandered to the south in Japanese waters, later began northward migrating in early May or before the end of June. Four of them were tracked back on breeding islands, and their migratory route showed an individual preference, only one seal did not enter into Okhotsk Sea. Restricted modes highly occurred in warm, shallow waters near the coasts of Japan and located relatively further from eddy edges. Individuals frequently appeared inside eddies when transiting the open waters. Our results suggest that NFS concentrated foraging effort
prior to northward migration, and that environmental influences might relate to their migratory momentum.

**Sex Differences in Socio-sexual and Agonistic S-postures of Belugas (Delphinapterus leucas)**

Malin Lilley¹, Jackson Ham², Devin Forey-Vargas³, Amanda Lozano⁴, Vivian Paredes⁵, Malin Miller⁶, Katie Kolodziej⁷, Heather Hill⁸
¹Texas A&M University- San Antonio, Jonestown, Texas, ²University of Lethbridge, Lethbridge, ³Texas A & M University- San Antonio, ⁴SeaWorld San Antonio, ⁵St. Mary’s University, San Antonio, Texas

Previous research identified the cetacean “s-posture” as an agonistic body posture, typically in the context of other aggressive behaviors such as open mouths, jaw claps, and chases. However, recent research on belugas (*Delphinapterus leucas*) reported a distinctive s-posture as part of socio-sexual display behavior, which is most common between immature, male belugas. Although both of these body positions resemble the letter “s,” hence the “s-posture” terminology, the exact body position is different in the socio-sexual context compared to the agonistic context. We documented sex differences in the use of these different body positions and accompanying contextual behaviors. Subjects were 20 belugas housed at SeaWorld San Antonio from 2007 to 2019. Videos of behavior were taken several times per month throughout this timespan. Within this dataset, s-postures events were identified and examined in further detail to document the exact body position during each s-posture and what other behaviors occurred before, during, and after the s-posture itself. Overall, socio-sexual s-postures, where the beluga’s genitals and head are directed towards the recipient, were accompanied by lateral presentations, pelvic thrusts, genital rubs, and erections. Although much less frequent and shorter in duration, agonistic s-postures, where the genital region is withdrawn, were typically accompanied by head jerks, open mouths, and bubbles. The vast majority of socio-sexual s-postures were performed by males and directed to other males or sexually immature females. Agonistic s-postures were performed by both males and females and directed to belugas of all ages and sex. Historically, s-postures have an aggressive connotation, which may not be accurate for all species, such as belugas. As more research is conducted on socio-sexual behavior in cetaceans, it is important to specify which s-posture is displayed and in what behavioral context.

**Cetacean Aerial Survey Project**

Emily Guarino¹, Alice Frye², Kirk Linaje³, Caitlin Hill⁴, Andria Beal⁵
¹Dolphin Research Center, ²Florida Atlantic University, Delray Beach, Florida, ³MORAES, ⁴Miami Beach, Florida, ⁵Florida International University

Cetacean species are notoriously difficult to study in the wild because of their size, mobility, and lack of continuous visibility (Nowacek et al., 2016). The use of unmanned aerial systems (UAS) has reduced these challenges and provides a stable, relatively quiet, and inexpensive platform that increases the ability of observation and sample collection for prolonged periods of time with minimal disturbance (Torres et al., 2018). The goal of this study was to collect photogrammetry data using a DJI Phantom 3 quadcopter to calculate body condition scores (BCS). The other goal of this study was to collect blow samples using the UAS to analyze various parameters of bottlenose dolphin (*Tursiops truncatus*) populations in the Florida Bay and to establish non-invasive sampling techniques to achieve these results. Photogrammetry data were first taken at various altitudes ranging from 3m to 10m from the resident population of bottlenose dolphins at Dolphin Research Center to standardize the UAS methodologies used and establish baseline BCS for healthy individuals.
The BCS were calculated by collecting measurements (e.g., total length, half girth (doubled)) from photos taken with the UAS using the software Morphometrix, and exporting these measurements to excel. Blow samples were collected using a petri dish that was swabbed and placed into a Žymo DNA/RNA shield for storage and processing. The sampling techniques and data collected in this study can be utilized to establish baseline BCS for bottlenose dolphins in the Florida Bay and improve conservation and ecological studies in an effort to minimize disturbance and potential detrimental effects on wild dolphins. References: Nowacek, D. et al. (2016), Studying cetacean behaviour: New technological approaches and conservation applications. Torres, L., et al. (2018), Drone Up! Quantifying Whale Behavior From a New Perspective Improves Observational Capacity.

Sex determination from humpback whale (Megaptera novaeangliae) blubber RNA
Jacob Linsky1, Rebecca Dunlop2, Michael Noad3, Lee McMichael4
1The University of Queensland, CLEVELAND, QLD, Australia, 2Cetacean Ecology and Acoustics Laboratories group, School of Veterinary Science, University of Queensland, Dunwich, QLD, Australia, 3Cetacean Ecology and Acoustics Laboratories group, School of Veterinary Science, University of Queensland, Gatton, Australia, 4The University of Queensland, Australia

An individual’s sex plays an important role in understanding the physiological and genetic features that describe their health. For some studies, however, physical or behavioural indicators of sex may not be observable at the time of sample collection. Here, we outline a novel method of sex determination from RNA using quantitative polymerase chain reaction (qPCR). RNA can also provide a range of information about an animal, including energy reserves, immune function and other indicators of health. Our method allows this information to be interpreted within the context of an individual’s sex, all from a single RNA extraction. To determine an individual’s sex, we detected the expression (or absence in males) of the X inactivation gene (XIST) in females. We applied this method to humpback whales (Megaptera novaeangliae) using RNA extracted from blubber (N=104). For validation, results are compared to a standard molecular sexing technique using the sex-determining gene (SRY) from genomic DNA extracted from skin tissue. We show that with adequate starting quantities of RNA (minimum of approx. 9 µg/ml), XIST sex determination shows 100% agreement with the SRY method from DNA. This novel method of RNA sex determination reduces costs in both labour and resources for gene expression studies by preventing the need to extract and analyse DNA. Going forward, the ability to reliably extract RNA from blubber also opens the potential for blubber gene expression to be used to monitor free-ranging cetacean health.

The Gulf of Mexico Marine Assessment Program for Protected Species (2017-2021): Developing and Disseminating New Density Models for Marine Mammals in the Northern Gulf of Mexico
Jenny Litz1, Lance Garrison2, Joel Ortega-Ortiz3, Gina Rappucci4, Melissa Soldevilla5, Keith Mullin6, Laura Aichinger Dias7, Anthony Martinez8, Kevin Barry5, Jonathan Reid8
1Marine Mammal and Turtle Division, SEFSC, NOAA Fisheries, Miami, Florida, 2Miami, FL, 3University of Miami, Cooperative Institute for Marine & Atmospheric Studies, Miami, Florida, 4Cooperative Institute for Marine and Atmospheric Studies, University of Miami, Hallandale, Florida, 5Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL, 6NOAA Fisheries Southeast Fisheries Science Center, Pascagoula, MS, 7CIMAS/UM, NOAA/SEFSC, Miami, Florida, 8Marine
The Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) is a multi-agency partnership focused on improving information on abundance, distribution, and habitat use of protected species in the U.S. Gulf of Mexico (GoMx). The cetacean portion of GoMMAPPS included line-transect surveys (3 aerial and 3 vessel) resulting in updated and improved abundance estimates for 26 cetacean stocks occurring in coastal, continental shelf, and oceanic waters. These updated abundance estimates are the first to include corrections for perception and availability bias in the GoMx and the first broad-scale vessel surveys to occur after the 2010 Deepwater Horizon oil spill.

GoMMAPPS data were combined with data from similar previous surveys to develop spatially explicit density models with environmental predictors describing oceanographic conditions derived from remotely sensed data and hydrographic models. The resulting models were used to develop monthly spatial density maps with predictions of animal density at monthly time scales. In addition, passive acoustic data were collected during vessel surveys to estimate the abundance of sperm whales and beaked whale species and to improve acoustic species classification of delphinids. The final products from GoMMAPPS will be publicly available to all interested stakeholders. These products satisfy many management needs including evaluating Deepwater Horizon restoration projects, informing permitting and consultations related to GoMx oil and energy production, and recovery planning for endangered species. The collaborative nature of this program should be a model for future efforts as it successfully allowed for the leveraging of resources for multi-taxon data collection from cetaceans, pelagic seabirds, and sea turtles. Continued surveys at consistent time intervals are needed to keep abundance estimates and density models current and to understand the variability in abundance and spatial distribution in response to dynamic environmental conditions, climate change, and anthropogenic stressors.

High levels of Carbon Monoxide (CO) in Three Tissues from Common Bottlenose Dolphins, *Tursiops truncatus*

Kerryanne Litzenberg¹, Kayleigh Herrmann¹, Kristi Kezar¹, D. Ann Pabst¹, William McLellan¹, Tiffany Keenan¹, Michael Tift¹

¹University of North Carolina Wilmington, ²University of North Carolina, Wilmington, NC, ³University of North Carolina Wilmington, Wilmington, NC, ⁴UNC Wilmington, Wilmington, NC, ⁵University of North Carolina, Wilmington, Wilmington, North Carolina

Carbon monoxide (CO) is produced naturally within the body, primarily through heme degradation. Marine mammals with large heme stores (i.e., hemoglobin and myoglobin) can produce high quantities of CO. Previous studies have found blood CO levels in deep-diving phocids to be as high as heavy cigarette smokers, however CO content has never been measured in other tissues of marine mammals. In terrestrial mammals, CO levels are highest in the liver and spleen, as these organs play critical roles in erythrocyte and heme degradation. We measured tissue CO concentrations in three different matched tissues (liver, spleen, and skeletal muscle) from 15 adult bottlenose dolphins, *Tursiops truncatus* (M=6, F=9). There was no significant difference in CO content among the three tissue types, or between sexes (p > 0.05). We also found no significant difference in liver or skeletal muscle CO concentrations between dolphins that had stranded live, and either died or were humanely euthanized (Code 1), or those found fresh dead (Code 2) (p > 0.05). However, Code 2 animals displayed significantly higher spleen CO concentrations, compared to Code 1 animals (p < 0.05). The average CO concentrations in all dolphin tissues were 4-13.5
times higher than values measured previously in similar tissues of healthy laboratory rodents. Similarly, CO concentrations in skeletal muscle of dolphins was 3.5 times higher than skeletal muscle CO from mice in a previous study that inhaled 500 ppm CO for 30 minutes. We hypothesize this result is due to higher myoglobin concentrations present in dolphin muscle. This study is the first to quantify CO in liver, spleen, and skeletal muscle of marine mammals. These data will provide critical information on the role of CO in regulating oxygen transport, and storage, in marine mammals. Work carried out under UNCW IACUC A17-18-011 & A2021-013; NOAA SE Stranding Agreement.

**Early diving behavior in Weddell seal (Leptonychotes weddellii) pups**

Emma Weitzner¹, Linnea Pearson¹, Lars Tomanek², Heather Liwanag³

¹California Polytechnic State University, ²California Polytechnic State University, San Luis Obispo, CA, ³California Polytechnic State University, San Luis Obispo, California

During the dependency period, marine mammal offspring must develop the behavioral skills that allow them to forage independently and thus survive into early adulthood. Deep-diving Weddell seals (Leptonychotes weddellii) are a model species for research on diving physiology, yet previous studies lack a thorough investigation into the diving behavior of dependent pups when they first begin to enter the water. To capture fine-scale dive behavior during the dependency period, we deployed time-depth-recorders (TDRs) on Weddell seal pups (n = 18) from the age of one week through seven weeks, during the 2017 and 2019 breeding seasons in McMurdo Sound, Antarctica. Dive parameters were correlated with time of day, age, sex, and weaning status to characterize diving behavior, and we used raw wet/dry data to determine which times of the day pups were most likely to be in the water. Pups made their deepest and longest dives and had the longest post-dive durations in the morning hours. Pups were in the water more during the late-night and morning hours than in the afternoon. Whereas dive depth significantly increased with age, dive duration significantly increased with both age and after weaning. Post-dive duration significantly decreased with age and after weaning. Taken together, these data indicate dependent Weddell seal pups may prioritize the development of swimming and navigational abilities as opposed to building and practicing foraging skills.

**Mixed-stock analysis of humpback whales in the North Pacific using DNA profiles**

Kelly Lizewski¹, Debbie Steel², Karen Lohman³, Renee Albertson², Ursula Gonzalez Peral³, Jorge Urban³, John Calambokidis², C. Scott Baker⁴

¹Oregon State University, Newport, Oregon, ²Fisheries and Wildlife Department and Marine Mammal Institute, Oregon State University, Newport, OR, ³Oregon State University, ⁴Department of Fisheries and Wildlife Sciences, Oregon State University, Newport, Oregon, ⁵Departamento de Ciencias Marinas y Costeras, Universidad Autónoma de Baja California Sur. La Paz, BCS México, ⁶Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico, ⁷Cascadia Research Collective, Olympia, ⁸Marine Mammal Institute, Oregon State University, Newport, OR

Humpback whales in the North Pacific migrate between winter breeding grounds in tropical waters to summer feeding grounds across the Pacific rim. Although breeding stocks are now recognized as Distinct Population Segments under the U.S. Endangered Species Act, the relationship of these stocks to feeding areas is complicated. Most of the recognized breeding stocks are comprised of individuals from multiple feeding areas, and similarly, feeding areas are used by individuals from multiple breeding stocks. To assess these stock mixtures
and to allocate feeding areas to source breeding stocks, we used mitochondrial DNA (mtDNA) haplotypes and 10 microsatellite loci from tissue samples collected during the program Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) from 2004-2006. We first used pairwise $F_{ST}$ values for mtDNA to assess differentiation of breeding stocks (n=1,219) and of feeding areas (n=1,309) according to several alternate stratifications of boundaries. We then applied mixed-stock analyses to select the scenario best suited for explaining humpback mixed stocks in the North Pacific. The preferred scenario apportioned each of the 6 feeding areas to 5 breeding stocks, Asia (the Philippines, Okinawa and Ogasawara), Hawaii, offshore Mexico (Revoltagigedo Islands), Mainland Mexico, and Central America. Results indicate there is mixing of individuals from at least two breeding stocks in all feeding areas except for southeast Alaska/Northern British Columbia, which is fully apportioned to the Hawaiian breeding stock. These results provide new insight into humpback migration connections to better assess conservation of the species.

Kate Lomac-MacNair1, Sheyna Wisdom2, José Pedro Andrade3, Julia Stepanuk4, Eduardo Esteves5

1CCMAR, Universidade do Algarve, Fritz Creek, Alaska, 2Fairweather Science LLC, Anchorage, AK, 3CCMAR, Centro de Ciências do Mar, Universidade do Algarve, Faro, Portugal, 4Stony Brook University, 5CCMAR, Centro de Ciências do Mar and Instituto Superior de Engenharia, Universidade do Algarve, Faro, Portugal

Evaluating the impacts of anthropogenic activities on Arctic wildlife is a key issue in current management and conservation strategies. With global climate change, expanding shipping routes, and increasing industrial development in the Arctic, the polar bear (*Ursus maritimus*) faces new challenges to its survival. Polar bear behavioral response to vessel presence is not well-documented. During the 2008–2014 Chukchi Sea Environmental Studies Program occurrence and behavioral data were collected during summer and autumn from vessel surveys for polar bears from the Chukchi Sea (CS) and Southern Beaufort (SB) subpopulations. We examined CS and SB polar bear occurrence and behavioral response to vessel presence by distance. During this study 56,901 km of observation effort occurred from 3 survey vessels and a total of 42 groups (50 individuals) of polar bears were recorded. Our results indicated that polar bears responded to vessel presence through ‘vigilance’ and ‘flee’ behaviors and that behaviors were related to distance from the vessel, group composition, and habitat type. Over half of the groups exhibited a behavioral response including all groups of mothers with cubs. The mean distance at which bears responded to vessels (805 ± 648 m) was closer than the mean distance at which no response was observed (2,001 ± 1,368 m). Logistic regression analysis revealed that response was associated with distance and our model indicated the estimated distance at which 50% of the polar bears would exhibit a behavioral response to be 1,645 m. Our findings are relevant to assess potential impacts of increasing vessel activity in the Arctic and to assist in the development of effective monitoring and mitigation strategies for polar bears.

Blowhole Temperatures as a Health Metric for Free-Swimming Large Whales
Gina Lonati1, Michael J Moore2, Daniel Zitterbart3, Sebastian Richter4, Jooke Robbins4, Natasha Hynes5, Kimberley Davies6

1University of New Brunswick Saint John, Franklin Lakes, NJ, 2Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, 3Woods Hole Oceanographic Institution, Woods Hole,
The endangered status of some large whale species, such as the North Atlantic right whale (NARW, Eubalaena glacialis), warrants close monitoring of individual and population health. Establishing quantitative metrics that can more efficiently gauge individual health will improve monitoring efforts. Internal body temperature is a common health metric for mammals; it is relatively stable in healthy individuals, but deviations can signify disease or injury. Currently, there is no standard method for measuring internal temperatures of free-swimming whales. Previous work has demonstrated that blowhole temperatures of captive odontocetes measured with infrared thermography (IRT) are within 1°C of internal (rectal) temperatures. We propose that blowhole temperatures could serve as a health metric for large, free-swimming whales, using IRT from a remotely piloted aircraft system (RPAS, commonly drone). Because there are several challenges to using RPAS-based IRT in aquatic environments to observe whales, we are developing calibration protocols that can be applied in the field to obtain accurate, absolute blowhole temperatures. These protocols were tested on individually identified humpback whales (Megaptera novaeangliae) with no apparent health concerns in the Bay of Fundy, Canada in 2020. Preliminary maximum blowhole temperatures averaged (±std) 27.0±3.0°C from four individuals. These protocols will be refined in the Gulf of St. Lawrence, Canada with NARWs in 2021. Even if blowhole temperatures are lower than internal temperatures recorded from other marine mammal taxa or from post-mortem whales, variation within and among individuals as well as relative differences could still provide insight into large whale health. Once calibration protocols are established, we plan to compare blowhole temperatures to body condition to further explore the potential of this health metric. Combined with other information that can be collected from whales with RPAS, IRT provides a fuller understanding of large whale health in the face of anthropogenic stressors and climate change.

pathroutr: An R Package for Re-Routing Marine Mammal Telemetry Paths Around Land

Josh London1, Devin Johnson2
1Alaska Fisheries Science Center's Marine Mammal Laboratory / NOAA Fisheries, Seattle, WA, 2NOAA Alaska Fisheries Science Center Marine Mammal Lab, Seattle, WA

The pathroutr package aims to provide a pragmatic and computationally fast solution for re-routing marine mammal telemetry paths around land barriers along an efficient path through water. Location estimates from biologgers deployed on marine mammals are commonly associated with large error estimates. For coastal species, this error often results in estimated movement paths unrealistically crossing land. A range of solutions for this issue have been employed over decades of bio-logging research. These solutions extend from simply removing locations on land to complex statistical models and processes that are computationally intense. None of these approaches have been widely adopted as a community best practice. With pathroutr we take the novel approach of applying the same road network routing technology available within mapping applications to the coastal marine environment. pathroutr creates a dense network of paths with a Delaunay triangle mesh. This triangulation mesh automatically adjusts the density of lines for more complex coastal features (e.g. peninsulas, lagoons, fjords). Once the network is created for a study area, fast algorithms for solving the shortest path through the network are used to re-
route segments of the telemetry track that cross land. While pathroutr does not provide a true statistical model for movement, and some caution should be considered in certain applications, this package and approach allows for a pragmatic, efficient re-routing of path segments that will improve our understanding of marine mammal habitat use within coastal regions.

Distribution of the Bigg’s Killer Whale Ecotype in the Salish Sea with Regards to Seasonality and Pinniped Vulnerability
Marena Long1, Athena Rycyk2
1New College of Florida, North Topsail Beach, NC, 2New College of Florida, Sarasota, Florida

The Bigg’s killer whale ecotype (Orcinus orca) is found in the coastal waters of the Northeast Pacific and is the only ecotype known to prey on other marine mammals in the Northern Hemisphere. Studies on the population of Bigg’s killer whales in the Salish Sea have been conducted, almost continuously, since 1994. However, few studies have looked at density distribution in regards to season and pinniped haul out sites. In this study, the relationship between the Bigg’s killer whale and pinnipeds was mapped according to season to determine if there are any patterns of spatial use, particularly with density. Location data provided by the Center for Whale Research were used to conduct kernel density and Getis-Ord Gi* hot spot analysis to compare distributions by season. These tests revealed a variation in hot spot locations among winter, summer, and spring, as well as among pinniped breeding, pupping, and post-breeding seasons. Kernel density indicated that Haro Strait and the upper areas of the Strait of Juan de Fuca have the most Bigg’s killer whale sightings regardless of season. Understanding seasonal spatial use of Bigg’s killer whales and how these movements affect their foraging practices can be used to better inform decisions regarding stock estimates, pinnipeds abundance, and resident killer whales’ status and habitat use in the area.

The Gulf of Mexico Proactive Regulatory & Observational Program: Conservation Through Industry Collaboration
Alex Loureiro1, Sarah Courbis2, Bernard Padovani3
1EnerGeo Alliance, Houston, Texas, 2Advisian Worley Group, Portland, Oregon, 3Marine Remote Systems

The National Marine Fisheries Service issues permits for incidental marine mammal harassment under the US Marine Mammal Protection Act. Authorizations are issued as individual incidental harassment authorizations (IHAs) for one year or under a five-year incidental take regulation (ITR), with individual projects receiving letters of authorization (LOAs). Historically, ITRs were applied to government programs. In January 2021, NMFS issued the first ITR that encompasses the programmatic activities of competitive industry interests. The Final Rule became effective in April 2021. LOAs are issued for geophysical activities related to oil and gas in the Gulf of Mexico. The ITR requires LOA holders to “collectively be responsible for compilation and analysis of [monitoring] data for inclusion in subsequent annual synthesis reports.” Four industry trade associations collaboratively developed a comprehensive program entitled the “Gulf of Mexico Proactive Regulatory and Observational Plan” (GOM-PROP) to achieve compliance with this provision. These associations, along with contractors, created a system that is adaptive and flexible and can serve as a model for future industry-focused ITRs. The approach to achieving this comprehensive reporting across dozens of companies with various contractors and subcontractors considered issues such as: (1) managing confidential business information while facilitating collaboration; (2) achieving
consistency in data collection and management; (3) logistics of compiling and storing data; (4) ensuring data collection meets analysis requirements; (4) achieving participation from LOA holders; (5) enabling industry to lead subsequent ITR development; and (6) funding the effort as an industry program. The GOM-PROP includes communications strategies, a comprehensive monitoring database, and data-appropriate analysis methods that consider the focus of monitoring (mitigation rather than assessment). The associations worked closely with United States regulatory agencies to ensure reporting will meet the standards and needs and will appropriately inform compliance and future permit applications.

Metastatic papillary adenocarcinoma in a rehabilitated South American sea lion (Otaria flavescens)

Julio Loureiro1, Karina Álvarez2, Juan Loureiro3, Sergio Rodríguez Heredia2, Romina Nuñez Favre4


In recent years, the cases of neoplastic disease observed in marine mammals have been growing. In pinnipeds, a high prevalence of cancer has been reported in California sea lion (Zalophus californianus) and was associated with environmental contamination and virus infection. Although a high cancer prevalence has been reported in California sea lions, little is known about this topic in South American sea lion (Otaria flavescens). Thus, this report aims to present a case of metastatic adenocarcinoma in a female Otaria flavescens. The sea lion was found stranded in La Plata River estuary and rehabilitated at Mundo Marino oceanarium. After rehabilitation, was group-housed with other sea lions at the oceanarium during 23 years. Unspecific clinical signs (progressive anorexia and lethargy) started two months prior to death with 28-yr (110 kg, straight length 1.9 m). Postmortem examination revealed firm homogeneous grey masses in the right ovary, the pancreas, right kidney, and diaphragm. Microscopic lesions were also found in adrenal glands, liver, peritoneum, and heart. Neoplasm cells were small in size with scarce cytoplasm and distinct borders. Cell nuclei were irregular and hyperchromatic. Cellular arrangement includes short papillary-like structures, scattered areas of glandular differentiation, small cell conglomerates, and areas of focal necrosis. This cellular arrangement was also observed in pancreas, peritoneum, liver, kidneys, adrenal gland, and cardiac stroma. Based on these findings, a metastatic papillary adenocarcinoma was diagnosed. Although the primary site was not determined, this report improves the information about neoplasm in South American sea lions. Further studies should include investigation of Otarine herpesvirus, blubber contaminants, genetic factors, and their associations to improve the knowledge of cancer in this species.

Covid-19 collateral damage: The pandemic’s effect on common bottlenose dolphins in and around Sarasota, Florida

Gretchen Lovewell1, Jessica Blackburn2, Amber Lea Kincaid3, Randall Wells4

1Mote Marine Laboratory, Sarasota, FL Florida, 2Mote Marine Laboratory, 3Mote Marine Laboratory and Aquarium, 4Chicago Zoological Society's Sarasota Dolphin Research Program,
The COVID-19 pandemic had ramifications that reached beyond the human toll. Mote Marine Laboratory’s Stranding Investigations Program (SIP) is the primary responder to cetacean strandings for the Florida counties of Sarasota and Manatee. This area overlaps with the study site of the Chicago Zoological Society’s Sarasota Dolphin Research Program (SDRP). Of the 135 cetaceans responded to by the SIP from 2011-2020, 44 were common bottlenose dolphins (*Tursiops truncatus*) known to the SDRP. The number of known individuals stranded per year from 2011-2020 ranged from two to ten, with an average of four (±2.67). In 2020, there was a marked increase in the number of stranded known individuals (n=10). The cause of stranding was not determined in five of the cases, however three of those five displayed signs of undetermined trauma. Four animals stranded with definitive signs of human interaction: three with fishery interactions and one with severe blunt force trauma from watercraft. One animal stranded due to natural causes. Eight of the ten animals recovered in 2020 were considered part of the multi-generational, year-round, resident community of Sarasota Bay and included all the human interactions. While there were no natural environmental phenomena of note for the area in 2020, there was an increase in the number of people recreating on the beaches and waterways during and after nationwide shutdowns due to the COVID-19 pandemic. Comparing historical trends to the findings of 2020 suggests that some of the members of the Sarasota Bay dolphin community were collateral damage of the large influx of people on the water. This level of loss is unsustainable and highlights the need for increasing efforts with conservation strategies such as targeted education, outreach, enforcement, and continued monitoring.

---

**Patterns of cortisol and corticosterone concentrations in humpback whale (*Megaptera novaeangliae*) baleen differ with cause of death**

Carley Lowe¹, Kathleen Hunt², Jooke Robbins³, Rosemary Seton³, Matthew Rogers⁴, Christine Gabriele⁵, Janet Neilson⁶, Suzie Teerlink⁷, C. Loren Buck⁸

¹Flagstaff, AZ, ²Smithsonian-Mason School of Conservation, Manassas, Virginia, ³Center for Coastal Studies, Provincetown, Massachusetts, ⁴Allied Whale, College of the Atlantic, ⁵NOAA Fisheries, Alaska Fisheries Science Center, Auke Bay Laboratories, Juneau, AK, ⁶Glacier Bay National Park, Gustavus, AK, ⁷NOAA Fisheries, Juneau, Alaska, ⁸Northern Arizona University, Flagstaff, Arizona

Baleen whales are subject to myriad natural and anthropogenic stressors but understanding how these stressors affect physiology is difficult. Measurement of adrenal glucocorticoid hormones involved in the vertebrate stress response (cortisol and corticosterone) in baleen could help fill this data gap. Baleen analysis is a powerful tool as it allows for a retrospective recreation of multiple years of glucocorticoid hormone concentrations at approximately a monthly resolution. We hypothesized that whales that died from acute stress (e.g., ship struck) would have lower levels of glucocorticoids along the baleen plate than whales that died following chronic stress (e.g., entanglement or illness with nutritional stress). To test this hypothesis, we extracted hormones from baleen plates of four humpback whales (*Megaptera novaenagliae*) that died from known causes: chronic entanglement (n=1, female), ship strike (n=2, male and female), or chronically ill and nutritional stressed (n=1, male). Over approximately three years of baleen growth and during multiple entanglements, the entangled whale had average corticosterone levels 1.8 – 2.9 times higher than the other whales but cortisol levels were similar to two of the other three whales. The nutritionally stressed ill whale showed a slow
increase in both cortisol and corticosterone spanning approximately three years, followed by a sharp decline in both hormones before death, possibly indicative of adrenal failure in this moribund individual. This whale’s correlation between cortisol and corticosterone was significant but showed no correlation in the other three whales. Our results show that cortisol and corticosterone concentrations vary according to cause of death and individual. Single point glucocorticoid concentrations should be interpreted with caution as low values can occur in whales experiencing pronounced stress and individual baselines can be highly variable. As more samples become available, the utilization of baleen as a retrospective resource to determine physiological patterns that underlie various stressors in baleen whales.

Tactile responses to environmental enrichment in captive Antillean manatee (Trichechus manatus manatus)

Karen Lucchini¹, Rebecca Umeed², Fernanda Attademo³, FABIA LUNA⁴, Luana Guimarães⁵, Bruna Bezerra⁶

¹Federal University of Pernambuco & Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos (ICMBio/CMA), Olinda, Pernambuco, Brazil, ²Programa de Pós-Graduação em Biologia Animal, Centro de Biociências, Departamento de Zoologia, Laboratório de Ecologia, Comportamento e Conservação, Universidade Federal de Pernambuco, Recife, Pernambuco, Brazil, ³Instituto Chico Mendes de Conservação da Biodiversidade / Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos, jaboatão dos guararapes, pernambuco, Brazil, ⁴ICMBio/CMA, Santos, SP, Brazil, ⁵Laboratório de Ecologia, Comportamento e Conservação, Universidade Federal de Pernambuco, Recife, Pernambuco, Brazil, ⁶Programa de Pós-Graduação em Biologia Animal, Centro de Biociências, Departamento de Zoologia, Laboratório de Ecologia, Comportamento e Conservação, Universidade Federal de Pernambuco, Recife, Pernambuco, Brazil

Tactile signals are essential for Antillean manatees communication and survival. However, we still know relatively little about their usage in response to environmental enrichment. This study aimed to assess captive Antillean manatees’ tactile responses to two stimuli (i.e., an infant model and an ordinary floating device). Also, we investigated gender’s influence in response to the infant model focusing on parenting-related behaviours such as “infant lifting”. We analysed the responses of eight adult individuals (four males and four females ranging from 10 to 33yrs). Our results show that exploratory behaviours towards the environment reduced during both stimuli exposition, but the manatees redirected exploration to the stimuli. The infant model caused a reduction in social behaviours towards the other animals in the oceanarium. The floating device caused no alteration in the manatee’s social behaviours performance. Females performed more parenting-related behaviours directed to the infant model than males, showing the evolutionary importance of tactile signals for the species. Our results show that it is possible to stimulate natural tactile behaviours in captive individuals using environmental enrichment practices. We highlight the importance of such an approach for manatees’ rehabilitation and reintroduction programs to avoid stereotypes. To improve the captive manatees’ quality of life, we highly recommend tactile stimuli practices in their routines. We also recommend continuous monitoring of their behaviours and developing studies focusing on Antillean manatees’ responses to social, physical, and spatial stimuli associated with other communication modalities.
Variability in Collisions Between Vessels and Humpback Whales (Megaptera novaeangliae) in Hawaiian Waters (1979 – 2021)
Edward Lyman¹, Marc Lammers², Adam Pack³, Amanda Bradford⁴, David Schofield⁵, Jens Currie⁶, Stephanie Stack⁶, Jeannine Rossa⁷, Allen Tom¹
¹NOAA Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, HI, ²Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, Hawaii, ³University of Hawaii at Hilo, Hilo, Hawaii, ⁴Pacific Islands Fisheries Science Center, NOAA Fisheries, Honolulu, Hawaii, ⁵NOAA Fisheries Pacific Islands Regional Office, Marine Mammal Health and Stranding Response Program, Honolulu, HI, ⁶Pacific Whale Foundation, ⁷Research Corporation of the University of Hawai‘i, University of Hawai‘i at Mānoa, Honolulu, HI

Injury and mortality from collisions with vessels is considered a major anthropogenic threat to whales worldwide. We examined 43 years (1979-2021) of confirmed reports involving collisions between vessels and humpback whales (Megaptera novaeangliae) on their breeding/calving grounds around Hawai‘i. In total, 131 whales were confirmed impacted by collisions with vessels: 100 were observed (self-reported or from other vessels), 27 had injuries consistent with a recent collision, and four were dependent calves of injured mothers. Of the 100 observed collisions, the majority (69.0%) were tour vessels, though many vessel types were involved. Most vessels of known length (96.7%, n=88) were under 20 meters. Most reporting vessels (56.6%, n=47) indicated speeds of 10 knots or less, but speeds ranged from stationary to 26 knots. While 82.6% (n=70) of collisions occurred while transiting, 17.4% (n=15) occurred while whale watching. Calves (n=52) represented 47.7% of known-aged reports, suggesting greater susceptibility. Leeward Maui had the highest incidence of collisions (66.0%, n=66). Comparison of reports in five-year bins shows a 40-fold increase in incidences through 2010 (0.2 to 8.0 collisions/year). While remaining a concern, reports have fallen over the past decade to an average of 5.4 collisions/year. Determinations of injury severity from 2007-2019 (n=72) indicate that an average of 2.1 whales/year are seriously injured from these collisions. Several factors affecting risk and reporting may explain variability in collision rates and impacts. For example, environmental fluctuations affecting whale presence on the breeding grounds (especially calves), reductions in vessel traffic due to the pandemic, and greater awareness from increased outreach and engagement. Accounting for these factors will better inform ongoing efforts to assess and mitigate the impacts of vessel collisions on humpback whales in Hawai‘i.

Assessing entanglement configuration and the resulting implications for rorquals in the Western Atlantic
Bob Lynch¹, Scott Landry², Paulette Durazo³, Maria Harvey⁴, Emily Kelly, David Mattila⁵, Michelle Silva, Jooke Robbins
¹Center for Coastal Studies, PROVINCETOWN, Massachusetts, ²Center for Coastal Studies, Provincetown, MA, ³Center for Coastal Studies, North Truro, MA, ⁴International Whaling Commission and Center for Coastal Studies

Large whale entanglement has been well documented in the western North Atlantic and is one of the leading causes of serious injury and mortality in some populations. Understanding the details of entanglement cases, including the configuration of gear on the body, would help discern what leads to entanglements and potentially prevent them in the future. This study summarizes gear configuration involved in the entanglement of four species of rorquals over two decades off the U.S. East Coast and Canadian Maritimes. Entanglements were reported to the Atlantic Large Whale Disentanglement Network and then examined first-hand by a disentanglement response team.
from the Center for Coastal Studies. In total, gear configuration was studied in 229 entanglement cases in which the location and nature of associated injuries were also assessed. Cases primarily involved humpback whales, but also included fin, minke and sei whales. For each case, we assessed the primary gear attachment points as well as the level of certainty about the entanglement configuration. We evaluate those results relative to the observed distribution of fresh injuries on the body. Finally, we discuss how entangling gear can physically interact with the morphology of whales under near-constant, forward movement in a water environment. These results provide insight into how whales contact gear, as well as guidance to scar based studies of entanglement for which gear types are not necessarily known and injuries from other sources can potentially be conflated with entanglement.

Foraging Ecology of Recovering Southern Sea Otters at the Northern Range Extent Informs Regional Population Dynamics and Lack of Expansion
Sophia Lyon¹, Joseph Tomoleoni², Julie Yee³, Nicole Thometz⁴
¹University of San Francisco, Burlingame, CA, ²US Geological Survey, Santa Cruz, CA, ³U.S. Geological Survey Western Ecological Research Center, Sacramento, California, ⁴University of San Francisco, San Francisco, CA

Sea otters (Enhydra lutris) are vital keystone predators within coastal ecosystems of the North Pacific that were nearly extirpated during the fur trade of the 18th and 19th centuries. Recovery of southern sea otters (Enhydra lutris nereis) in North America has proceeded slowly, with individuals still missing from much of their historic range. Prey availability is recognized as a key factor regulating sea otter populations, making data pertaining to foraging behavior and rates of energy intake valuable metrics for assessing regional population status. Although studies have been conducted across the majority of the current range in California (USA), little is known about southern sea otter foraging ecology or population dynamics at their northern range extent, where a historic lack of range expansion has limited recovery. Thus, we collected fine-scale census and foraging data of sea otters at Año Nuevo State Park from October 2019 to March 2021 to determine seasonal abundance, diet composition, diet diversity, and energy intake rates. We compared data from this study with previously collected data throughout the current range, including high- and low-density populations, to evaluate the status of southern sea otters at the northern range extent. We found that the diet at Año Nuevo is primarily composed of crabs, urchins, clams, and infaunal worms. The average rate of energy intake (9.66 kcal/min ± 0.96 CI₉₅) was relatively low when compared to other low-density sites. Additionally, dietary diversity (using Shannon-Wiener index) was intermediate between previously studied high- and low-density sites (H=1.81). These data reveal potential limitations in the prey resource base at the northern range edge, help inform local population dynamics, and provide additional insight into potential reasons for the stagnation in northward range expansion. Ultimately, this information can be used by management and conservation agencies to improve strategies for promoting southern sea otter recovery.

Reproductive parameters of bowhead whales (Balaena mysticetus) inferred from baleen steroid hormones.
Nadine Lysiak¹, Claire Hornby², Steven Ferguson², Mads Peter Heide-Jørgensen³, Cory Matthews²
¹Suffolk University, Stockton Springs, ME, ²Fisheries and Oceans Canada, Winnipeg, Manitoba, ³Greenland Ins. of Natural Resources, Copenhagen K, Denmark

Patterns of long-lived bowhead whale (Balaena mysticetus) reproductive cycles have been
estimated in two stocks (Bering-Chukchi-Beaufort, BCB and Eastern Canada-West Greenland, EC-WG) through extensive survey effort and gross examination of reproductive tracts following subsistence harvest. Recent validation studies indicate that longitudinal profiles of steroid hormones in baleen record evidence of pregnancy, calving, and exposure to other stressors. To assess gestation period and calving interval at high resolution in individual whales, we measured progesterone, corticosterone, and stable isotope ratios at 2-cm intervals in the baleen plates of 10 females from the EC-WG population. Repeated, sustained elevations in progesterone, indicating pregnancy, were observed in 7 of 10 females – representing whales of body size $\geq 14.32$ m. The average duration of progesterone elevations was 21.6-25.6 months, significantly longer than the 14-month gestation period that has been previously suggested for this species. Progesterone peaks were bimodal – with a coincident, prolonged corticosterone peak occurring in the latter half and persisting through the end of pregnancy. The average duration of the dual progesterone/corticosterone elevation was 10.5-14.83 months. We suggest that the first half of a baleen progesterone elevation represents hormonal secretions associated with estrous and ovulation, while the second half (progesterone/corticosterone elevation) represents active gestation. Interbirth intervals ranged from 12.4-40.0 months, with significant intra- and inter-individual variability. Three females had uniformly low progesterone concentrations across their entire plate, and were from an area where immature animals aggregate, supporting previous findings of seasonal sex and age-class segregation in this population. These hormone-derived estimates, which are the first population-specific estimates of reproductive rates for EC-WG bowheads, will inform parameters in population growth models used to manage their recovery while maintaining culturally important hunts.

Trouble in Paradise? Expanded Photo Analysis Techniques Reveal High Rates of Fishery-Related Scarring on Bottlenose and Pantropical Spotted Dolphins in Maui Nui, Hawai‘i

Abigail Machernis1, Stephanie Stack2, Grace Olson1, Florence Sullivan1, Jens Currie2
1Pacific Whale Foundation, Wailuku, HI, 2Pacific Whale Foundation

Worldwide, interactions with fisheries have been identified as one of the leading conservation concerns for cetaceans resulting in lethal or non-lethal consequences. Increasing incidences of interactions highlight the need to determine the extent and implications of this threat on the conservation and stability of impacted populations. In Maui Nui, Hawai‘i, limited information is available on the level of impact fisheries interactions have on the island-associated populations of common bottlenose (Tursiops truncatus) and pantropical spotted dolphins (Stenella attenuata). To quantify the number of individuals with evidence of fisheries interactions, this study examined images of bottlenose and spotted dolphin’s dorsal fins, mouthlines, and bodies that were photographically identified during survey efforts from 1996 to 2020 in waters surrounding Maui Nui. Our results revealed that 27% of the 255 identified bottlenose dolphins and 13% of the 374 identified spotted dolphins displayed one or more fishery-related scars. These findings document one of the highest rates of bottlenose dolphin-fisheries interactions compared to previous reports for this species. Our methodology of reviewing above and underwater footage for mouthline and body images increased dorsal only scar-detection rates by 51% for bottlenose and 40% for spotted dolphins. Future surveys should expand dorsal fin photo-identification efforts to include above and underwater mouthline and body images to increase scar-detections rates and ensure more accurate reporting. Our results, in conjunction
with a recently reported decline in the Maui Nui bottlenose dolphin population, suggest that fisheries interactions may pose a serious threat to this population of bottlenose dolphins and is a concern for spotted dolphins. With significant overlap between pelagic and nearshore commercial and recreational fishing and the two species' distribution, this information is a critical first step to inform management and conservation efforts that address minimizing potentially life-threatening injuries to two island-associated populations.

Characterizing Sei Whale (Balaenoptera borealis) Vocalizations Heard in Atlantic Canada
Gabrielle Macklin1, Hilary Moors-Murphy1
1Fisheries and Oceans Canada, Dartmouth, Nova Scotia

Passive acoustic monitoring (PAM) is a commonly used non-invasive and long-term method of studying cetaceans. Sei whales (Balaenoptera borealis) are an elusive, poorly studied species, and little is known about their year-round occurrence off eastern Canada. While PAM may be an effective tool for sei whale research, we must first describe sei whale vocalizations with confidence. This study sought to better characterize sei whale vocalizations heard in Atlantic Canada, including possible variation by location and seasonality. Acoustic recordings were collected throughout Atlantic Canada between 2015-2017 and analysed for sei whale vocalizations (downsweeps). Downsweeps were categorized by recording station, season, and call type (singlets, doublets, triplets+). Various time and frequency measurements of calls were taken. Sei whale downsweeps recorded in Atlantic Canada were longer and had a lower maximum frequency than those described from previous recordings off the northeast USA. Downsweeps were significantly longer in Emerald Basin, Nova Scotia (F5 = 20.047, p < 0.001), in the fall season (F3 = 15.04, p < 0.001), or when produced as part of the doublet call type (F2 = 11.38, p < 0.001). There was a greater proportion of the doublet call type in the fall and at stations off Newfoundland; however, they occurred in equal proportion to singlets in other seasons and at stations off Nova Scotia. Well-defined sei whale calls will support future PAM studies by allowing for the development of more accurate automated sei whale call detectors and more efficient analysis protocols.

Death-birth-intervals Reflect Maternal Investment in Indo-Pacific Bottlenose Dolphins (Tursiops aduncus).
Meredith MacQueeney1, Molly McEntee2, Ewa Krzyszczyk2, Janet Mann3
1Georgetown University, St. Petersburg, FL, 2Georgetown University, Washington, DC

Few terrestrial mammals exhibit the level of maternal investment in a single offspring that is observed in Indo-Pacific bottlenose dolphins (Tursiops aduncus) in Shark Bay, Western Australia. After a 12-month pregnancy, calves nurse for an average of 4 years, a pattern rivaling great apes and elephants. With such prolonged maternal investment, infanticide (documented in this genus) could benefit non-fathers by inducing cycling and providing an opportunity to father the subsequent calf. To determine the viability of this strategy, we investigated how calf age at death affected time to next conception by examining death-birth intervals (DBIs) for offspring born to 123 female dolphins over a 35-year period. Calf age at death was key; DBIs increased with calf age up to two years. Early loss, when the calf is <3 months, averaged a DBI of 19 months; the DBI for calves 3-12 months was 23 months. Calf loss during mid-lactation (12-24 months) delayed conception considerably, with a DBI of 30 months. When calf loss occurred under 12 months, some females
conceived rapidly (within 2 months) compared to the average; however, no females conceived rapidly when calf mortality occurred after 12 months of age. These results suggest that infanticide is potentially an adaptive strategy only during a brief post-partum window, as males would have little chance of sequestering or gaining access to the female at her next conception in this dynamic fission-fusion social system. However, in of itself, the reproductive delays observed here do not explain the apparent absence of infanticide in the Shark Bay population. Additional factors are likely relevant. Also, DBIs are a good indicator of the arc of maternal investment during lactation.

Area of adipocytes as indicators of the energy reserve of gray whale Eschrichtius robustus, in the Laguna de San Ignacio, Baja California Sur, Mexico

Lorena Magallón¹, Lorena Viloria Gomora¹, Jorge Urban², Steven Swartz³, Sergio Martínez Aguilar⁴, Germán Isauro Garrido-Fariña⁵
¹Universidad Autonoma de Baja California Sur, La Paz, Baja California Sur, Mexico, ²Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico, ³Laguna San Ignacio Ecosystem Science Program, Darnestown, ⁴Programa de Investigacion de Mamiferos Marinos, Mexico, City, ⁵Universidad Nacional Autónoma de México, Cuautitlan Izcali, Estado de México, Mexico

Body condition (BC) is an indicator of the physical condition that gives a relative measure of an individual's energy reserves. Therefore, it is considered an indicator of reproductive success and general health. The evaluation of BC can be done through adipocytes, which are cells that store excess energy from food, transforming it into fat. In cetaceans, adipocytes make up a specialized tissue, the blubber. It is known that blubber adipocytes change their cell area in response to modifications in the use and accumulation of energy, dependent on migration and reproduction events. The present study proposes to evaluate the adipocyte area of the gray whale during its reproductive aggregation and to interpret the state of energy reserves as BC. During the 2020 aggregation season, 139 blubber biopsies were obtained, in Laguna de San Ignacio, BCS, Mexico. All were preserved for histological processing, that is, cutting, staining with Hematoxylin-Eosin, and permanently mounted on slides. All the slides were checked and 120 chosen for morphometric analysis. This analysis consisted of taking photomicrographs (10X) in fields with at least 100 adipocytes. After which, the cell area was measured. The analysis represented 65 single individuals, 24 mothers, and 31 calves. It was possible to associate 18 mothers with their respective calf. Preliminary results indicate that 15 single individuals can be classified as normal, 24 acceptable, 25 poor, and 1 unknown. In addition, they reveal a decrease in the area of the mother's adipocytes during the season (41,798 to 17,691 µm²), in contrast to an increase in the calves (1,830 to 24,650 µm²). However, for both groups it is not possible to define a BC categories (normal $x^\bar{} = 31,039$ µm², SD=4990.43; acceptable $x^\bar{} = 3,0268$ µm², SD=7346.47; poor $x^\bar{} = 28,537$ µm², SD=6828.16). Adipocyte area was a good indicator to evaluate BC.

Long-term associations, life history, and lack of dispersal: unique insights from pygmy killer whales off the island of Hawai‘i

Sabre Mahaffy¹, Robin Baird², Brittany Hanser³
¹Cascadia Research Collective, Olympia, Washington, ²Cascadia Research Collective, Olympia, WA, ³Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, La Jolla, CA

Several species of blackfish are known to live in long-term social groups composed of related adults and their offspring, with offspring remaining in the group for life. In contrast, little is known about the life history and social
structure of pygmy killer whales (*Feresa attenuata*). We used a long-term (1987-2018) photographic dataset to examine sighting history and a restricted dataset (2000-2018) to examine group structure and associations of a commonly seen, resident group of this species from Hawai‘i Island. Over the 19-year period 32 individuals were considered to be part of this social cluster. Individuals were sexed genetically (n=7), by the presence of a post-anal keel (n=9), or by repeated calf associations (n=1), and adults were considered sexually and physically mature if seen ≥20 years (n=7). Biopsy samples from seven individuals revealed they all shared the same mitochondrial haplotype (based on a 671 bp section of the control region), suggesting they all share a common maternal ancestor. Maximum association indices (median=0.81) within the mixed age/sex group were high over the 19-year period, indicating stable, long-term associations. Four adult males were seen from 24.1-31.8 years, including the individual with the longest sighting history, last photographed in 2017. Three adult females were seen from 24-26.1 years with 3-4 calves and had a median inter-calving interval of 4.5 years (range=3-7 years). The sex of younger calves is unknown, however older male calves remained associated up to 14.9 years, after the onset of sexual maturity, even after new calves were born, suggesting male philopatry to the natal group. Limited underwater observations indicate some spatial segregation between mom/calf subgroups and all-male subgroups. While more research is needed to confirm lack of dispersal of male and female offspring, this study demonstrates the value of long-term datasets for examining social organization and life history of poorly-known species.

Changing Patterns in Pinniped Abundance and Distribution in British Columbia, Canada

Sheena Majewski¹, Wendy Szaniszlo¹, Chad Nordstrom², Strahan Tucker³

¹Fisheries and Oceans Canada, Nanaimo, British Columbia, ²Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, BC

Since protection in the early 1970s, systematic aerial surveys have documented recovery of pinniped populations in British Columbia (BC) from intensive predator control programs. Trends in abundance and distribution of three pinniped species over the past decade are examined using counts from aerial photos and telemetry-based correction factors to estimate abundance. While Pacific harbour seal (*Phoca vitulina richardii*) numbers increased exponentially during the 1970s and 1980s, they have remained stable since the mid-1990s. There are currently an estimated 105,000 harbour seals in BC with ~39,000 occurring in the Strait of Georgia, the region with the highest density of harbour seals in (13.2 seals/km). Although overall numbers have remained stable since 2010, there is evidence of continuing redistribution among regions and haulout sites. Steller sea lion (*Eumetopias jubatus*) abundance continues to increase, with the recovery and expansion of rookeries and year-round haul-out sites. A northward shift in breeding sites has been observed, including establishment of four new rookeries (sites with >50 pups) since 2010. There are an estimated ~43,000 Steller sea lions in BC during the summer breeding season and ~53,000 overwintering in BC waters. Larger numbers of Steller sea lions estimated from winter surveys as compared to breeding season surveys appear to be due to a net influx of animals from other parts of their range. A northward shift in California sea lion (*Zalophus californianus*) overwintering range has also been observed, with a dramatic expansion of haul-out sites and increase in numbers of California sea lions overwintering in BC waters since 2010. These recent trends in abundance and distribution of sea lions in BC are significant in the context of ongoing changes in oceans conditions and have important ecological implications, including increased availability of pinniped prey for marine mammal hunting killer
whales and increased competition for sensitive fisheries resources.

**Global variation in shape and size of orca (Orcinus orca) saddle patches**

**Pirjo Makelainen¹, Ingrid Visser², Tracy Cooper³, Mathieu Cusson⁴**

¹University of Helsinki, Helsinki, ²Orca Research Trust, Tutukaka, New Zealand, New Zealand, ³Wellington, New Zealand, ⁴Université du Québec à Chicoutimi

By the 1970’s, saddle patches of *Orcinus orca* (killer whale / orca) were recognised as unique to each individual and by the 1980’s, researchers began to establish that there were also differences in general saddle patch shapes between populations and ecotypes. More recently, with data-sharing and identification catalogues readily available online, comparisons of populations and ecotypes at a global level are potentially more robust. We compared the saddle patches of > 3,900 orca, from 48 geographically or ecologically divided groups, using six variants. For the first time, we assessed saddle patch width on a global scale, using a ratio measurement (comparing the width of the saddle patch to the width of the dorsal fin). We found global differences in saddle patch shape, however there were certain shapes that were more prevalent than others. One shape (‘Smooth’) was found worldwide in all but one group (from Fiji, in the Pacific Ocean) and eight groups exhibited only ‘Smooth’ saddle patches. In contrast, nine groups exhibited five saddle patch types. Size ratios differed across Ocean basins with the highest variability observed in the Southern Hemisphere. When size was compared across geographic groups, the narrowest saddle patches were found on New Zealand Coastal orca and the widest on the Crozet Islands. Our study may help researchers to identify undescribed ecotypes, or more clearly differentiate sympatric ecotypes, and thereby help assessments for marine Management Authorities and policy makers in the creation of recovery or conservation plans.

**Belugas Count! in Alaska – A collaborative effort to raise awareness and promote recovery of the endangered Cook Inlet beluga**

**Jennafer Malek¹, Verena Gill²**

¹NOAA Fisheries, Alaska Region, Anchorage, Alaska, ²NOAA Fisheries, Anchorage, Alaska

Cook Inlet belugas are an endangered population of whales in Alaska. Surveys by NOAA during the 1990s showed an alarming decline in the population size, likely due to overhunting by Alaska Natives. Concerns about the decline resulted in a voluntary suspension of the subsistence hunt in 1999. However, the population did not recover as expected and has continued to decline with only about 279 whales left, earning it the designation of one of nine of NOAA’s “Species in the Spotlight” (SIS). The SIS initiative brings attention and resources to save the species most highly at risk of extinction. As part of this effort, the Belugas Count! event began in 2017 by NOAA and a broad spectrum of partners from the State, NGOs, ANOs, private industry, and education institutions. This free public event combines in-person viewing sessions with staffers viewing stations along the shores of Cook Inlet, followed by a festival. At stations, the public helps staff look for belugas and sightings are recorded. The data provides a snapshot of where the belugas were located around Cook Inlet on Belugas Count! day every September. During the festival, the public engage in activities, talks from beluga experts, and interact with Belugas Count! partners. This event has led to a new program; the Alaska Beluga Monitoring Partnership (AKBMP.org) being formed which has citizen scientists monitoring daily from March-May and August-November at 4 stations. While Belugas Count! was canceled in 2020 due to the pandemic, it will continue in a pandemic-safe manner in 2021 and is a successful example of bringing the public
together to foster local pride, awareness, and stewardship of an endangered SIS species. We hope Belugas Count! can serve as a model for other marine mammals species that are in need of a collaborative effort to move towards recovery.

Understanding Outcomes and Lessons Learned from Live Large Whale Strandings in the United States: 2006-2019

Stephen Manley¹, Deborah Fauquier², Sarah Wilkin³, Trevor R. Spradlin⁴, Aleria Jensen⁵, Kate Savage⁶, David Schofield⁷, Justin Viezbicke⁸, Justin Greenman⁹, Kristin Wilkinson⁴⁰, Blair Mase-Guthrie¹¹, Erin Fougeres¹², Mendy Garron¹³, Ainsley Smith¹⁴, Teresa Rowles¹⁵

¹NOAA/NMFS/OPR, ²NOAA Fisheries, ³National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD, ⁴NOAA/NMFS Office of Protected Resources, Marine Mammal & Sea Turtle Conservation Division, Silver Spring, Maryland, ⁵NOAA Fisheries, Juneau, AK, ⁶NOAA Fisheries Juneau Protected Resources Office, Juneau, AK, ⁷NOAA Fisheries Pacific Islands Regional Office, Marine Mammal Health and Stranding Response Program, Honolulu, HI, ⁸NMFS, Portland, OR, Oregon, ⁹NOAA Fisheries, Long Beach, CA, ¹⁰NOAA Fisheries, Protected Resources Division, Seattle, Washington, ¹¹NOAA/NMFS/SEFSC, Miami, FL, ¹²NOAA Fisheries Southeast Regional Office, St. Petersburg, FL, ¹³NOAA National Marine Fisheries Service, ¹⁴National Marine Fisheries Service, Greater Atlantic Region, Gloucester, Massachusetts, ¹⁵Silver Spring, Maryland

Strandings of live large whales [baleen (Mysticeti spp.) and sperm whales (Physeter macrocephalus)] are relatively rare in the United States. We reviewed the frequency, distribution, and outcomes of live large whale strandings from 2006 through 2019 to inform management decisions and response efforts by the U.S. Stranding Network. All large whale stranding records in the National Marine Mammal Stranding Database were reviewed, and the species, age class, circumstances of the stranding and response, and ultimate disposition of each individual was determined. For live stranded whales that subsequently died, the probable or confirmed cause of stranding/death was determined, when possible. During the study period, 128 large whales were confirmed stranded alive at the initial observation, representing only 6% of the total 1,939 confirmed large whale stranding events. The frequency of live vs. dead strandings varied by species as well as geographic region. The majority of live stranded whales were assessed as being in poor health 46% (59) or young, dependent calves 29% (37). While 31% (40) of the live stranded whales initially refloated (naturally on a high tide or with human assistance from bystanders or trained responders), only 12% (15) of all live stranded whales were presumed to have ultimately survived the stranding event, although follow-up information is limited. This study highlights the need to: (1) increase access to improved methods for safely, quickly, and humanely euthanizing individuals with a poor chance of survival; and (2) develop better refloating tools and techniques for the relatively rare cases where the prognosis of the live stranded whale is favorable and the species has a proven record of successful refloating. The authors thank the U.S. Marine Mammal Stranding Network for responding, collecting and providing the data used in this study.

Taking too many? Try MAMSE: A new conservation tool to estimate fisheries bycatch limits in a changing environment

Oliver Manlik¹, Robert Lacy², William Sherwin¹, Hugh Finn³, Neil Loneragan⁴, Simon Allen⁶

¹University of New South Wales, Sydney, United Arab Emirates, ²Chicago Zoological Society, Brookfield, Illinois, ³University of New South Wales, Sydney, Australia, ⁴Curtin University, Bentley, Australia, ⁵Murdoch University,
Human-caused mortality of wildlife is an ongoing threat to biodiversity. Assessing the population-level impact of mortality from fisheries bycatch and other anthropogenic sources has typically relied upon deterministic methods. However, population declines are often accelerated by stochastic factors that are not accounted for in such conventional methods. Building upon the widely applied Potential Biological Removal (PBR) equation, we introduce a new population modelling approach for estimating sustainable limits to human-caused mortality. Our approach, termed ‘Maximum Anthropogenic Mortality in Stochastic Environments’ (MAMSE), incorporates stochasticity, including variation in vital rates and the dependency of offspring on their mothers. The MAMSE mortality limit indicates the maximum number of individuals that can be removed without causing negative stochastic population growth. We used MAMSE to assess the impact of dolphin mortality from bycatch for an Australian trawl fishery. The results suggest that even the lower skipper-reported dolphin bycatch mortality rates are unsustainable in the long-term. We calculated a PBR of 16.2 dolphins per year. In contrast, the MAMSE model, indicated that only 2.3 to 8.0 dolphins could be removed annually without causing a population decline in a stochastic environment. The difference between the PBR and MAMSE mortality limits confirms previous studies that deterministic approaches like PBR may underestimate the true impact of bycatch mortality. This highlights the importance of integrating stochasticity when evaluating the impact of bycatch or other human-caused mortality on wildlife populations. Although population viability analysis (PVA) has previously been used to evaluate the impact of human-caused mortality, MAMSE represents a novel PVA framework to set acceptable levels of human-caused mortality. It offers a broadly applicable, stochastic addition to the demographic toolbox to evaluate the impact of human-caused mortality on wildlife, especially marine mammals. This is particularly salient given the broadening spectre of climate change-induced fluctuations in even historically stable ecosystems.

Baleen whales as a bioindicator of long-term ecological changes in the North Atlantic Ocean
Farzaneh Mansouri1, Kerri J. Smith1, McKayla Miller2, Richard Sabin3, Alex Aguilar4, Asunción Borrell5, Stephen Trumble6, Sascha Usenko1
1Baylor University, 2Baylor University, Waco, TX, 3Natural History Museum, London, United Kingdom, 4University of Barcelona, Barcelona, Spain, Spain, 5Universitat de Barcelona, Barcelona, Spain, Spain, 6Baylor University, Waco, Texas

Assessing long-term changes in the marine food web structure and ecosystem function is difficult due to both the scale and complexity. Additionally, climate change impacts on marine ecosystem such as sea surface temperature, nutrient cycle, primary productivity, and community composition, accelerated the rate of change in the world’s ocean. Stable isotope can be used to monitor alterations in marine ecosystem and assess community and ecosystem levels changes. Using stable isotope composition archived in long-lived marine mammal tissues could help us to improve our understanding of climate change impacts on biogeochemical process and primary productivity through time. Recent advance in science and developing a new technique of combining age estimates with stable isotope composition of baleen whale earplug provide life history stable isotope profiles which preserved both behavior and ecological changes. In this study, carbon (d13C) and nitrogen (d15N) were measured in North Atlantic fin whale earplugs (N= 14, n= 774 laminae) to provide
chronological foraging ecology and migration dataset spanning 5 decades at 6-month resolution. Result of d\(^{13}\)C and d\(^{15}\)N values demonstrated distinct fin whale’s subpopulations in the North Atlantic Ocean. Additionally, oxygen (d\(^{18}\)O), and sulfur (d\(^{34}\)S) stable isotope combined with d\(^{13}\)C and d\(^{15}\)N values were used to determine isotopic landscape (i.e., isoscape) and geolocate fin whales in the North Atlantic Ocean. Suess corrected d\(^{13}\)C profiles suggest that over half (57%) of fin whales earplug demonstrated long-term declining trends that could be indicative of regional-scale ecosystem levels changes driven by direct and indirect climate drivers.

**Geographical movements, site fidelity and connectivity of killer whales (Orcinus orca) within and outside herring (Clupea harengus) grounds in Icelandic coastal waters.**

Tatiana Marchon\(^1\), Filipa Samarra\(^2\), Marianne Helene Rasmussen\(^3\)

\(^1\)University of Iceland, Reykjavik, Iceland,\n\(^2\)University of Iceland, Vestmannaeyjar, Iceland,\n\(^3\)Húsavík Research Center, University of Iceland, Húsavík

Previous studies of killer whales in Icelandic coastal waters show that whales regularly move between seasonal herring grounds. Indeed, killer whales are mainly sighted within herring grounds, nevertheless they are present all-around Iceland. However, we know little about movements outside of these areas. In this study, we used photo-identification data to investigate the movements, site fidelity and connectivity of whales occurring within (South - S, and West - W, Iceland) and, for the first time, outside (South West - SW, North West - NW, and North East - NE, Iceland) herring grounds. From the 398 individual whales identified sighted more than once, 43% were resighted between herring grounds; only 1% between areas outside main herring grounds; and 24% between areas within and outside herring grounds, from which SW accounted for 22%. Although SW seems to be a passing route linking the herring grounds in S and W, 55% of the whales sighted in SW were only resighted in W, with 11 of those individuals known to feed on higher trophic level prey, other than herring thus suggesting they are not migrating between seasonal herring grounds. In addition, although the number of matches between NE and other areas was relatively low (3 individuals with SW and 4 with W), the matches occurred with regions where some whales known to feed at a higher trophic level occur. Thus, whales with mixed diet might move between SW, W and NE. Individuals sighted in the NE (n = 44) are sighted primarily in this area and are not resighted often. Whales sighted in NE might, thus, be a part of a larger offshore population that occasionally visit this area. The results show that Icelandic killer whales have complex movement patterns and population structure, that should be considered in future conservation and management strategies.

**Importance of Photo-Identification of Humpback Flukes, Dorsal Fins, and Body Scars for Whale Disentanglement**

Stephanie Marcos\(^1\), Peggy Stap\(^2\), Victoria Wade\(^1\), Julia E. O’Hern\(^3\)

\(^1\)Marine Life Studies, Moss Landing, California,\n\(^2\)Marine Life Studies, Moss Landing, CA

Photographing the pattern on the underside of humpback whale flukes is the most common methodology used to identify individuals. Although this practice is easy and highly reliable, there are situations where humpbacks cannot display their flukes when sounding. Whales that become entangled in lost/abandoned fishing gear or marine debris may lead to restricted mobility, sometimes inhibiting a whale from lifting its flukes for photo-identification used by researchers or rescuers. The West Coast Large Whale Entanglement Response Network (WCLWERN) relies on photos from the
reporting party if there is no vessel standing by to relocate the injured whale. The dorsal fin shape along with body scars can be used to identify individual humpbacks. This can be very useful in identifying an entangled whale that needs to be rescued or re-sighting a previously entangled individual to monitor the health and condition of the whale after disentanglement. These photos are also often easier for the public or eco-tourism operations to obtain. As members of the WCLWERN, Marine Life Studies’ Whale Entanglement Team (WET)® carry a full complement of disentanglement tools during research and conservation surveys within the Monterey Bay National Marine Sanctuary. Opportunistic photographs of humpbacks during odontocete surveys (NMFS Permit) along with photos gathered during entanglement responses, resulted in 868 unique humpback whales sighted and identified from 2006 to 2018 fieldwork. The increase of entanglements through the last decade precipitates an ever-increasing need for photo-identification of individuals made from multiple sources: flukes, dorsal fins, and body scars, to support a better understanding of entanglements on population health. In this study, we review the importance of this methodology during our boat surveys and whale rescue responses.

Assessment of conservation Organizations’ effectiveness regarding cetacean conservation in the Western Atlantic Ocean

Marcela Marega-Imamura1, Yvonnick Le Pendu2, Leonardo de Carvalho Oliveira2, Alexandre Schiavetti2, Alonso Aguirre3, E.C.M. (Chris) Parsons4

1Universidade Estadual de Santa Cruz, Brazil, 2Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil, 3George Mason University, Fairfax, Virginia, 4U.S. National Science Foundation (NSF)

Conservation Organizations focused on cetaceans have played an important role in minimizing the risk of threats and fostering the recovery of dolphins and whales worldwide. This study seeks to provide data to stimulate and strengthen partnerships and provide lessons that may help the organizations improve the effectiveness of cetacean conservation. Our major goal was to examine which factors influence this effectiveness. From questionnaires surveys, we investigate Conservation Organizations concerned with cetacean conservation from Argentina, Brazil, Uruguay, and the US. Our results indicate that the number of Conservation Organizations has been growing since 1895. The action fields most cited by participants were (a) outreach and education; (b) conducting their own cetacean research, and (c) participating in Governmental issues/trying to influence policy. The main factors that influenced the effectiveness of participants efforts at cetacean conservation were: (a) level of financial resource; (b) number of staff; (c) variety of spatial extent of action; (d) number of studied species; (e) number of publications; (f) the intensity of collaboration; and (g) number of fields of work. The main difficulties mentioned were: (a) fundraising and (b) lack of political influence at Federal, State, and Local government levels. We also found that the collaboration between organizations is limited. We highlighted that there are locations lacking cetacean-related study, which require conservation effort. There is a need for studies on bycatch and marine debris threats. We conclude that: (a) fundraising skills; (b) capacity to translate scientific information to decision-makers; (c) basic research on species biology and environmental characteristics; (d) networking capacity are features of paramount importance. We recommend organizations to (a) assess their conservation effectiveness, (b) recognize the features which warrant special attention, (c) identify their networking performance and potential partnerships, (d) enhance bridges for Conservation Organization cooperation, and (e) expand their work in locations lacking cetacean research.
Maternal Investment Strategies in Marine Mammals: A Phylogenetic Comparative Approach
Jennifer Maresh¹, Chris Law², Sarah Kerr³, Daniel Costa⁴, Danielle Adams⁵
¹West Chester University, West Chester, PA, ²UC Santa Cruz, American Museum of Natural History, Santa Cruz, CA, ³West Chester University of PA, ⁴Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, ⁵Clemson University, Clemson, SC

Many marine mammals move between distinct habitats for feeding and reproduction, with specific reproductive strategies that reflect the temporal and spatial scales of their movements. In previous work we have shown that despite the diversity of reproductive strategies, marine species tend to invest relatively less time and energy in gestation and more in lactation compared to other large-bodied mammals; however, we also found moderate-to-strong phylogenetic signals in some indicators of maternal investment. In this study, we were interested in determining the degree to which patterns of maternal investment in marine mammals might be explained by their migratory habits versus their membership in a particular mammalian clade (or both). This question is particularly intriguing given the long-distance migrations that characterize the life histories of many Cetartiodactyls. We synthesized information from multiple datasets in the scientific literature for approximately 900 placental mammals, including various indicators of maternal investment: gestation time, fetal and offspring growth rates, mass at birth, litter size, lactation time, and mass at weaning. Information on home range size and residency behaviors were then used to assign each species to one of four movement categories: territorial, central place forager, nomadic, or migrator. To test for differences between groups, we will perform phylogenetic generalized least-squares regressions and analysis of covariance on mass-corrected maternal investment indicators, and use phylogenetic comparative methods to identify shifts in the tempo and mode of evolution across mammalian clades. We suspect that marine mammal maternal investment strategies are not the product of the marine environment per se, but rather, that they are reproductive behaviors that are (1) somewhat conserved across mammalian clades with a shared phylogeny, and (2) adaptive for mammals constrained by the spatial and temporal dynamics of large-scale seasonal migrations between feeding and breeding grounds.

How to detect the impact of microplastics and related plastic additives in cetaceans of the SPAMI Pelagos Sanctuary: the Plastic Busters MPAs approach
Fossi Maria Cristina¹, Matteo Baini², Matteo Galli³, Massimiliano Rosso⁴, Paola Tepsich, Teresa Romeo⁵, Daniel Zalko⁶, Cristina Panti⁷
¹University of Siena, Siena, Siena, Italy, ²University of Siena, Siena, Siena, Italy, ³University of Siena, Siena, Italy, Italy, ⁴CIMA Research Foundation, Savona, Savona, Italy, ⁵ISPRA, ⁶INRA Toxalim, France

The Mediterranean Sea is one of the most polluted area of microplastics (MPs) in the planet. Plastic Busters MPAs (PBMPAs) is a 4-year-long Interreg EU Med-project aiming to contribute to maintaining biodiversity and preserving natural ecosystems, against marine litter, in Mediterranean marine protected areas (MPAs). The overarching aim of this presentation is to describe the implementation of the PBMPAs harmonized monitoring approach to detect the impact of marine litter (particularly MPs) on Mediterranean biodiversity, focusing mainly on cetacean species inhabiting the largest pelagic SPAMI of the Mediterranean Sea, the Pelagos Sanctuary, and in the coastal MPA Tuscan Archipelago National Park-PNAT. In 2019, researchers of 8 European institutions, monitored 2230 nautical miles, collecting 140
samples of superficial microplastics in the two study areas and carrying out monitoring of surface macrolitter with simultaneously monitoring of biota. The entire sampling design was guided by the development of a marine litter distribution model in order to identify the possible marine litter hot spot areas and of the potential impact on biodiversity. High MPs concentrations were detected in the studied areas, with higher values in PNAT (mean 0.36±0.61 items/m²) than Pelagos (mean 0.18 ± 0.58 items/m²). During the sampling campaign, in order to assess the ecotoxicological impact on cetaceans, 17 skin biopsies samples of fin whale (Balaenoptera physalus) and 24 samples of striped dolphin (Stenella coeruleoalba) were collected and further analyzed, for metabolomics investigation and plastic additives (phthalates). The use of 1H-NMR metabolomics studies carried out, for the first time, on cetacean biopsies, with the modelling of multi-omics data into Metabolic Networks, and the subsequent toxicological interpretation of the pathways modulated by xenobiotics exposure, could be an extremely relevant tool for discriminating the potential impact of microplastics and related plastic additives on cetaceans inhabiting this fragile and highly anthropized ecosystem.

Although studies have modeled the influence of environmental conditions on dolphin distribution, there is still a gap in assessing the influence of human activities associated with these conditions. We expect that oceanographic characteristics related to their prey and feeding tactics and anthropized areas such as shipping routes and port complexes, directly influence dolphin distribution, since dolphins have high energy requirements, feeding on prey with great mobility and depend on vocalization to coordinate group activities. We ran 300 distribution models, including six algorithms, and generated an ensemble model to predict the occurrence of common bottlenose dolphins (Tursiops truncatus truncatus) in the state of Rio de Janeiro, Brazil, a coastal area in the Western South Atlantic Ocean. Sea surface temperature, primary productivity, current velocity, seabed slope and ocean pollution (shipping routes + proximity to ports) were used as explanatory variables. Three variables were most important: primary productivity, slope and ocean pollution, in decreasing order of importance. Dolphins’ occurrence was higher in areas with lower primary productivity, indicating that eutrophic waters, enclosed by bays and estuaries, may be unsuitable for their occurrence. Dolphins were most sighted in areas less sloped on the continental shelf, indicating their coastal preferences. The most suitable areas were closer to port complexes and shipping routes. We warn the overlap among dolphins, ports and related activities such as vessel traffic may cause behavioral modification, temporary and permanent abandonment of habitats and ultimately boat strikes. Therefore, protective measures must be undertaken to protect common bottlenose dolphins along the Rio de Janeiro coast.

Modeling common bottlenose dolphin habitat use in a coastal and anthropized area
Guilherme Maricato¹, Rodrigo Tardin¹, Liliane Lodi¹, Israel Maciel¹, Maria Alice S. Alves¹
¹Rio de Janeiro State University, Rio de Janeiro, Rio de Janeiro, Brazil, ²Department of Ecology, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil, ³Whales & Dolphins of Rio de Janeiro Project, Brazil, ⁴Federal Rural University of Rio de Janeiro, ⁵State University of Rio de Janeiro, Brazil

It is important to understand the processes that determine species distribution, particularly for species that have an extensive home range and are exposed to various environmental conditions.
Comparative anatomical study of sound production and reception systems in the common dolphin (Delphinus delphis) and the harbour porpoise (Phocoena phocoena) heads
ARRIBART Marion, GOVEN, France

Magnetic resonance imaging (MRI) and computed tomography (CT) scans were used to analyse, respectively, the soft tissues and the bones of the heads of four common dolphins and three harbour porpoises. This imaging study was completed by an examination of anatomical sections performed on two odontocete heads (a subadult common dolphin and a subadult harbour porpoise). The three complementary approaches allowed to illustrate anatomical differences in the echolocation systems of the common dolphin and the harbour porpoise. We captured images confirming strong differences of symmetry of the melon and of its connexions to the MLDB (Monkeys Lips/Dorsal Bursae) between the common dolphin and the harbour porpoise. The melon of the common dolphin is asymmetrically directly connected to the right bursae cantantes at its right side, whereas the melon of the harbour porpoise is symmetrical, and separated from the two bursae cantantes by a set of connective tissues. Another striking difference comes from the bursae cantantes themselves, less deeply located in the head of the common dolphin than in the harbour porpoise.

Foraging behavior of gray whales during extended migratory stopovers in San Francisco Bay
Tim M Markowitz1, Isidore Szczepaniak2, Bill Keener3, Bekah Lane4, Allison Payne4, Barbie Halaska4, Padraig Duignan5, Marc Webber6, Andrew Chang7
1The Marine Mammal Center, Corte Madera, CA, 2The Marine Mammal Center, Corte Madera, California, 3San Francisco State University, Golden Gate Cetacean Research, Dana Point, California, 4The Marine Mammal Center, Sausalito, California, 5The Marine Mammal Center, Woodstock, IL, 6Smithsonian Environmental Research Center, Tiburon, CA

During one of the world’s longest migrations (~16,000-22,000 km roundtrip), gray whales (Eschrichtius robustus) journey along the west coast of North America between winter breeding grounds in Baja, Mexico and summer feeding grounds in the Arctic. In the past, migrating gray whales were occasionally observed to briefly enter San Francisco Bay, the largest estuary on the west coast and a heavily trafficked port area. In 2019-2021, coincident with an Unusual Mortality Event, multiple gray whales remained for extended periods in the bay during the spring northward migration. We collected information on gray whale use of the bay, including positions, behavioral data, and photo-identification records from a research vessel, whale watching vessels, shore stations, and the Golden Gate Bridge. Photo-identification records confirmed individuals remained in San Francisco Bay for up to a month, and >1 whale was commonly sighted (daily maximum = 5 individuals). Whales routinely utilized areas well inside the bay, near Angel, Alcatraz and Treasure Islands. During 2019-2020, apparent foraging behavior was observed, with whales diving regularly in shallow water. In 2021, feeding behavior was confirmed for three photo-identified whales in San Francisco Bay, with observations of mud plumes for each whale during multiple surfacing events. Foraging behavior occurred in water depths ranging from 12-21 m with dive duration averaging 5-8 minutes. Subsequently, necropsies of two gray whales in the bay revealed stomach contents indicating recent feeding. This is the first confirmed case of gray whales feeding in San Francisco Bay during extended migratory stopovers. San Francisco Bay offers a sheltered habitat for gray whales to rest and feed but also increases the risk of ship strike, as there is a high degree of overlap between whale habitat and vessel traffic, including areas frequented by recreational vessels, commercial shipping lanes,
Haul-out behaviour and anthropogenic disturbance of an increasing population of seals in the UK

Sarah Marley¹, Phylippa Foster², Joseph Stephens², Christian Rivers-Martin⁵, Robyne Castles², Fiona Woods¹, Peter Hughes⁴, John Arnott⁴, Louise MacCallum⁵
¹Scotland’s Rural College (SRUC), Portsmouth, Hampshire, United Kingdom, ²University of Portsmouth, Portsmouth, United Kingdom,
³University of Portsmouth, Henley, Oxfordshire, United Kingdom, ⁴Chichester Harbour Conservancy, Chichester, West Sussex, United Kingdom, ⁵Langstone Harbour Board, Hayling Island, Hampshire, United Kingdom

Harbour seals (Phoca vitulina) and grey seals (Halichoerus grypus) both occur within the UK, but display contrasting population trends. Whilst grey seals are typically increasing in number, harbour seals have shown varying patterns since experiencing severe pandemics in recent decades. There is a need for monitoring of regional and local populations to understand overall trends. This study utilised a 20-year dataset of boat-based seal counts from two neighbouring harbours in the Solent region of southeast England, supplemented with six months of dedicated, land-based behavioural surveys. Generalised Additive Models (GAMs) showed a significant increase in the numbers of both species over time, although site-specific differences existed. Accompanying photographic-identification data supported this increase and suggests evidence of site fidelity, with a total of 68 harbour and eight grey seals identified.

Further GAMs based on behavioural observations investigated haul-out patterns in relation to temporal and environmental variables, revealing patterns linked to season, time of day, tidal state, temperature, and wind speed. Seals were particularly abundant in the summer months approximately 2-hours after low tide. Concerningly, behavioural surveys also showed high levels of anthropogenic disturbance in this area, primarily from seasonal increases in recreational boating activity. Over 100 disturbance events were observed, with approximately 20% resulting in seals fleeing from the haul-out site. Disturbance events were more prevalent in summer, on weekends, and in response to kayaks, canoes, and motorboats with large crews.

Overall, this study shows reasons for both hope and concern. The rising number of seals suggests the Solent is an increasingly important area for these species, particularly as a pupping site for harbour seals. However, this area also experiences high anthropogenic pressure, which has direct overlap with periods of peak seal abundance and the harbour seal pupping season. Increased public awareness campaigns targeting recreational boaters are recommended to help mitigate disturbance events.

Decadal changes in anthropogenic injuries in southern right whales (Eubalaena australis) off Argentina for the period 1971-2019

Carina F. Marón¹, Florencia Vilches², Lucia Alzugaray³, Agustina Donini¹, Matias Di Martino⁵, Vicky Rowntree⁶, Marcela Uhart⁷, Mariano Sironi⁸
¹Universidad Nacional de Cordoba and Instituto de Conservacion de Ballenas, Argentina, ²University of California Santa Cruz, Instituto de Conservacion de Ballenas, Santa Cruz, CA,
³Southern Right Whale Health Monitoring Program, Puerto Madryn,, Chubut, Argentina, ⁴Southern Right Whale Health Monitoring Program, Puerto Madryn, Chubut, Argentina, ⁵Programa de Monitoreo Sanitario Ballena Franca Austral, Buenos Aires, Argentina, ⁶Department of Biology, University of Utah, Salt Lake City, Utah, ⁷University of California, Davis and Universidad del Centro de la Provincia de Buenos Aires, Argentina, Puerto Madryn,
Ship strikes and entanglement are major conservation threats for cetaceans. Southern right whales (*Eubalaena australis*) breeding off Peninsula Valdés, Argentina, migrate between this calving ground and their Southwest Atlantic feeding grounds, and overlap with vessel traffic and fisheries. To assess changes in anthropogenic injuries over decades, we analyzed photographs of living individuals taken during annual aerial surveys at Peninsula Valdés in 1971-2017, and photographs and data taken during necropsy examinations in 2003-2019. Injuries were classified by type (ship strike, entanglement, or unknown human interaction). We found 141/3,800 (4%) living whales with signs of anthropogenic injuries, of which half (49%) were recorded in the 2000s-2010s. Most injuries were present in adults (84%, n=118), and the minority in calves (8%, n=12) and juveniles (5%, n=7). Of the 141 cases, 19 (13%) were entanglement injuries and 69 (49%) signs of ship collisions. During the 70s, living whales with entanglement injuries represented 7% of the total injured whales, while in the 2000s-2010s they increased to ~30%. Whales with injuries from ship strikes have averaged ~50% of the total injured over the five decades. We found 23/557 (4%) dead whales with anthropogenic injuries of which 70% (n=16) were calves followed by adults (17%, n=4) and juveniles (13%, n=3). Most recorded injuries were from ship collisions (87%, n=20) and fewer cases were from entanglements (13%, n=3).

Overall, we report an increment in the number of injured whales from the Valdés population, especially in the last two decades. Considering the impacts that anthropogenic injuries have in other populations (e.g. the critically endangered *E. glacialis*) our results indicate a future threat for the right whales of Argentina if management decisions to minimize human impacts are not made in the short term.

Organochlorine contaminants and striped dolphin (*Stenella coeruleoalba)*: no solution has been found for a thirty-year-long Mediterranean pandemic.

**Letizia Marsili**, Cecilia Mancusi, Giuliana Terracciano, Valeria Paoletti, Chiara Caruso, Enrica Franchi, Ilaria Ceciarini, Carlo Amico, Laura Carletti, Alessandra Neri, Matteo Lodovichi, Fabrizio Cancelli, Guia Consales

1University of Siena, Siena, SI, Italy, 2Environmental Protection Agency, ARPAT, Livorno, Italy, 3IZS Lazio e Toscana, Pisa, Italy, 4Associazione Elbamare, Cavo, RIO (LI), Italy, Italy, 5University of Siena, Siena, Italy, Italy, 6University of Siena, Siena, Italy

Since 1988, mass strandings of striped dolphin specimens, usually concentrated over short periods of time (a few months), have occurred along the coasts of the Mediterranean Sea, including the Italian ones. The first stranding event was particularly dramatic and occurred between 1990 and 1992 affecting a large part of the basin. In Italian waters other relevant events also occurred, especially in 2013 an exceptional number of striped dolphins stranded along the Tyrrenian coast of Italy in just three months. Diagnostic post-mortem investigations pointed out that dolphin morbillivirus (DMV) played an important role in this mortality outbreak causing pulmonary and neurological diseases. In many cases, the analysed cetaceans were affected by severe coinfections involving cetacean-specific viruses, anthropogenic zoonotic pathogens and/or microbial agents. The majority of these specimens also showed another type of "disease", represented by organochlorine contaminants (HCB, DDTs and PCBs). Their levels exceeded both the tolerance thresholds established for no deleterious effects in marine mammals and the toxicological hazard threshold established for the striped dolphin of the Mediterranean Sea. Organochlorine-associated immunosuppression, especially if co-existing with DMV infection, could have made them more susceptible to
Arctic marine mammals are facing many challenges which are often linked to climate change. One important challenge is increased ship traffic, which leads to underwater noise, ship strikes, and pollution. Underwater noise, in particular, can be pervasive, causing noticeable impacts to marine life from large distances. Marine mammals can face behavioural disturbance, acoustic masking, and even hearing damage if they are exposed to enough underwater noise. Beluga (*Delphinapterus leucas*) and bowhead whales (*Balaena mysticetus*) are endemic Arctic cetaceans and are highly evolved to live in an ice-covered environment. Like other whales, they rely heavily on acoustic communication, and there is significant overlap between some of their vocalizations and noise created by ships. Both species migrate through areas with the highest levels of traffic in the Pacific Arctic and are potentially exposed to a high number of acoustic disturbance events. In this study, we examine ship tracks derived from satellite Automatic Identification System (AIS) data and assess the overlap between tagged beluga and bowhead whales calculated from satellite telemetry data collected between 2012 and 2018 in the Beaufort and Chukchi Seas. For beluga whales, we combine dive data metrics with movement data from the tags deployed in 2018 to identify a behavioural response in individual whales to interactions with ships. Understanding how beluga and bowhead whales react in response to ship noise is currently poorly understood, yet is a critical component of predicting how increased ship traffic may impact these species. The information obtained from this study will help to inform the management of ship traffic in important areas for beluga and bowhead whales, and may be increasingly useful as ship traffic increases in the Arctic, particularly if industrial projects such as mines continue to cause increases in ship traffic in areas that have had little traffic in the past.

Assessing the exposure and behavioral responses of beluga (*Delphinapterus leucas*) and bowhead (*Balaena mysticetus*) whales to ships and ship noise in the Pacific Arctic

Morgan Martin¹, William Halliday², Luke Storrie³, John Citta³, Jackie Dawson³, Lois Harwood⁴, Nigel Hussey⁵, Francis Juanes⁶, Ellen Lea⁶, Lisa Loseto⁷, Shannon MacPhee⁸, Lisa Moore⁹, Adrian Nicoll¹⁰, Greg O’Corry-Crowe¹¹, Lori Quakenbush¹², Stephen Insley¹²

¹University of Victoria c/o Wildlife Conservation Society Canada, ²Wildlife Conservation Society Canada, ³University of Manitoba, Winnipeg, Manitoba, ⁴Alaska Department of Fish and Game, Fairbanks, Alaska, ⁵University of Ottawa, ⁶Fisheries and Oceans Canada, Yellowknife, Northwest Territories, ⁷University of Windsor, ⁸University of Victoria, Victoria, ⁹Fisheries and Oceans Canada, Inuvik, NT, ¹⁰Fisheries and Oceans Canada/Freshwater Institute, Winnipeg, Manitoba, ¹¹Fisheries and Oceans Canada, Winnipeg, ¹²Wildlife Conservation Society Canada, Whitehorse, Yukon, ¹³Geospatial Data Scientist at Transport Canada, ¹⁴Florida Atlantic University, ¹⁵Alaska Dept. Fish and Game, Fairbanks, Alaska
First evidence of mutual mother-pup vocal recognition in the extremely colonial Cape fur seal
Mathilde Martin¹, Tess Gridley², Simon Elwen³, Isabelle Charrier⁴
¹Université Paris Saclay, CNRS, Orsay, France, ²University of Cape Town, Cape Town, Western Cape, South Africa, ³Stellenbosch University, Cape Town, South Africa, ⁴Université Paris-Saclay, Université Paris-Sud, CNRS, Institut des Neurosciences Paris-Saclay, 91405 Orsay, France, Orsay, France, France

The Cape fur seal is one of the most colonial mammals in the world with breeding colonies of several hundred thousand individuals. On land, individuals of all ages communicate acoustically in order to facilitate their social interactions i.e. territoriality, sexual competition, mate selection and maternal care. This results in a high level of background noise and a strong risk of confusion among individuals. During the lactation period, which lasts up to 11 months, females are regularly separated from their pup to forage at sea for several days. The ability of mother-pup pairs to reunite afterwards is therefore as challenging as it is crucial for the survival of the young, which depends exclusively on its mother. In contrast to many otariid species for which the importance of acoustic signals in the mother-pup reunion process has been studied, the individual vocal recognition in the Cape fur seal has never been investigated. Females (n = 11) and pups (n = 17) were both tested using playback experiments involving filial and non-filial vocalizations, as well as mother and non-mother's vocalizations respectively. Both females and pups responded significantly more to the filial pup's or mother's calls (e.g. looking at the speaker, approaching and/or calling) than to the stranger's calls, testifying to the existence of a mutual vocal recognition. One-week old pups showed strong responses to their mother's calls, suggesting that vocal recognition occurs before the first separation, and might even occur soon after birth in Cape fur seals. Interestingly, the strength of pups’ responses to their mother decreased with age and may be linked to changes in their nutritional needs as well as their attention level towards their mother and their motivational state.

The first dedicated cetacean field studies in El Salvador
Diana Martínez¹, Nicola Ransome², Melvin Castaneda³, Mirna Rebeca Valencia Vargas⁴, Marlenne Vazquez Cuevas⁵, Marvin Morán⁶
¹Santa Ana, El Salvador, ²Murdoch University, ³Fundación Naturaleza El Salvador, Acajutla, Sonsonate, El Salvador, ⁴Universidad Iberoamericana de México, Santa Ana, Santa Ana, El Salvador, ⁵Proyecto Megaptera El Salvador, Acajutla, Sonsonate, El Salvador, ⁶Proyecto Megaptera, Universidad de El Salvador, El Congo, Santa Ana, El Salvador

In El Salvador, cetacean research has been very limited. The recent implementation of the National Cetacean Conservation Program of the Ministry of Environment and Natural Resources of El Salvador has given special emphasis to the development of new research in the country. Although there are 21 cetacean species listed as inhabiting Salvadorian waters, there have been no dedicated field studies to support this information. The present study aimed to document cetacean species found along the Salvadorian coast, by conducting vessel surveys during three sighting seasons. Suverys departed from the coastal settlements of Los Cóbanos (2015, 2020, 2021), La Libertad (2020) and La Unión (2021), aboard small artisanal fishing boats (<8m). During the surveys we observed one cetacean species of the family Balaenopteridae, the humpback whale (Megaptera novaeangliae), and three species of the family Delphinidae, the pantropical spotted dolphin (Stenella attenuata), bottlenose dolphin (Tursiops truncatus) and striped dolphin (Stenella coeruleoalba). In addition, we collected visual evidence (videos and photographs) from
local fisherman of the presence of orca killer whales (*Orcinus orca*), false killer whales (*Psuedorca crassidens*) and Bryde’s whales (*Balaenoptera edeni*) en aguas salvadoreñas. Las imágenes recolectadas también permitieron la creación del primer catálogo de fotoidentificación de ballenas jorobadas y orcas asesinas en El Salvador. Esta investigación representa el primer esfuerzo de estudio dedicado para identificar las especies de cetáceos presentes en las aguas costeras del país.

**Gray whale stranding records in Mexico during the Unusual Mortality Event (2019-2022)**

Sergio Martinez Aguilar1, Patricia Casanovas2, Andrés González3, Monica Farriols4, Fabián Castillo-Romero5, Everardo Meléndez6, Noe López-Paz7, Steven Swartz8, Lorena Viloria Gomora9, Floryser Ronzón Contreras10, Minerva Valerio-Conchas11, Jorge Urban12

1*Programa de Investigacion de Mamiferos Marinos, Mexico, City, 2Programa de Investigación de Mamíferos Marinos (PRIMMA), Universidad de Baja California Sur (UABCS), Laguna San Ignacio Ecosystem Science Program (LSIESP), British Veterinary Association (BVA), British Divers Marine Life Rescue (BDMLR), Barcelona, Catalunya, Spain, 3Laguna San Ignacio Ecosystem Science Program (LSIESP), Programa de Investigación de Mamíferos Marinos (PRIMMA), Universidad de Baja California Sur (UABCS), 4Laguna San Ignacio Ecosystem Science Program (LSIESP), Programa de Investigación de Mamíferos Marinos (PRIMMA), Universidad de Baja California Sur (UABCS), 5Exportadora de Sal, S.A, Baja California Sur, 6Reserva de la Biosfera El Vizcaíno, Mulegé, Mexico, 7Reserva de La Biosfera El Vizcaíno, *8Laguna San Ignacio Ecosystem Science Program, Darnestown, 9Universidad Autonoma de Baja California Sur, La Paz, Baja California Sur, Mexico, 10Departamento Académico de Ciencias Marinas y Costeras- UABCS, La Paz, Baja California Sur, Mexico, 11Programa de Ciencias marinas y Costeras-UABCS, La Paz, BCS, Mexico, 12Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico

Unusual Mortality Events (UME) occur when mortalities increase above an average annual rate. In 2019 the U.S. National Oceanic and Atmospheric Administration declared a gray whale UME along the North Pacific coast of North America. In Mexico, there were 277 gray whale stranding records between 2019 and 2022 (81, 88, 55 and 53 respectively). The majority of the whales (76.6%) stranded in Ojo de Liebre lagoon and the surrounding areas. 114 of these whales were females, 114 males, and 49 were of undetermined sex. The age classes of the dead whales were: 135 adults, 60 subadults, 54 yearling whales and 25 calves. The number of strandings is likely an underestimate of actual mortalities, because of: differences in detectability, the dimensions of the area where the gray whales are distributed along the Baja California Peninsula and the differences in search effort conducted, mainly due to COVID-19 restrictions in 2020 and 2021. Even when the examination of some of the stranded whales suggested that a decline in body condition may have contributed to the increase in gray whale mortality, this hypothesis has not been confirmed due to a high number of carcasses with an advanced decomposition, so the cause of UME for gray whales is still undetermined.

**Using drones to improve pinniped monitoring on a coastal island**

Daniela Martins Machado Oliveira1, Aline Kellermann2

1ICMBio, Wildlife Refuge Ilha dos Lobos, Torres, RS, Brazil, 2Chico Mendes Institute for Biodiversity Conservation (ICMBio), Wildlife Refuge Ilha dos Lobos, Torres, Rio Grande do Sul, Brazil

Unmanned Aerial Vehicles (UAV’s, drones), can
be a non-invasive and low-cost tool that can improve on the studies of marine life. In the Wildlife Refuge of Ilha dos Lobos, a marine protected area, located in Torres’s coast, Rio Grande do Sul, Brazil, this tool is being used since 2018 for monitoring the presence of pinnipeds. Pinnipeds are marine mammals that are often observed in large groups on haul-out sites, within which can be difficult to count and differentiate, when observing at land or boat. Usually, these animals are monitored by observer counts, or on manned aerial surveys, which can have limitations or high costs for operation. In total, 69 drone flights were conducted with a DJI Phantom 4® operated from the continent, at about 1.8 kilometers from the site, between the years of 2018 and 2020, on days of favorable flight conditions. Maintaining a subtle flight pattern and an average of 30m of height above the animals, they showed no signal of disturbance associated with the equipment. The quality of the images captured was good enough to count and identify each individual and it was possible to observe natural social behaviors. Based on the surveys conducted so far, and previous studies on this subject, a monitoring protocol was written for the study area. With this document it is possible to create a pattern on data collection and compare data throughout the years. With the addition of this tool as a way of monitoring, even with its limitations on climate conditions such as rain and high winds, we noted that the precision on the counting of pinnipeds was improved, making age, sex, and behavior observations easier, with a low cost and effort at conducting the activity.

Parasites can have negative impacts on marine mammal health and, as the oceans change, parasite abundance is probably changing as well. Despite this, little is known about how the burden of parasitism has changed for marine mammals. One parasite family frequently found in the intestines of marine mammals are nematodes (i.e., roundworms) in the family Anisakidae (anisakids). Once inside their marine mammal definitive host, anisakids can cause both direct and indirect fitness costs. Recent studies have revealed a global trend of increasing anisakid abundance, but few of those data have been collected from the northeastern Pacific. Rising anisakid burdens may pose a threat to many marine mammal species, but especially those whose populations are already declining and facing cumulative stressors, like the endangered southern resident killer whale (SRKW) population. We sought to determine how anisakid abundance of key SRKW prey species has changed over the past 80 years in Puget Sound, Washington, USA by dissecting and conducting parasitological analysis of museum specimens of common prey species and ecologically important forage fish. We dissected a representative sample of Pacific herring (Clupea pallasii), Pacific hake (Merluccius productus), surf smelt (Hypomesus pretiosus), striped surfperch (Embiotoca lateralis) and walleye pollock (Gadus chalcogrammus) collected over the past 80 to 100 years. We identified all nematodes found within the fish to the species level and used generalized linear mixed-effects models to determine whether there has been a change in parasite abundance over time. Our results suggest that marine mammals face different parasitological risks now than they did in the past.

Historical change in the abundance of anisakid parasites in key marine mammal prey species of Puget Sound, WA, USA. Natalie Mastick¹, Rachel Welicky², Whitney Preisser², Katie Leslie², Evan Fiorenza¹, Katherine Maslenikov², Luke Tornabene², John M. Kinsella¹, Chelsea Wood³

¹University of Washington, ²School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA, ³University of Washington, Seattle, WA, ⁴HelmWest Laboratory
From Sky to Shining Sea: Integrating remote sensing and field-based surveys to map the consequences of mining on South American sea lions (Otaria byronia)  
Mariah Matias¹, Carlos Francisco Yaipen-Llanos²  
¹Organization for Research and Conservation of Aquatic Animals - ORCA PERU, ²Organization for Research and Conservation of Aquatic Animals - ORCA PERU, Surco, Lima, Lima, Peru

As stated by the Latin American Observatory of Mining Conflicts, approximately 90% of Latin American countries have been impacted by negative externalities from mining activities. While the coastal regions of Peru have often been deemed as “new mining frontiers,” local communities have expressed concerns on its adverse effects and are still forced to face the continuation of such projects. Given that the vast majority of pollution to marine environments is sourced from land, the harmful effects of mining pollution extend beyond our species, affecting both marine wildlife and humans. Influence on marine mammals may take the form of many impacts, including noise from seismic surveys, drilling, chemical impacts associated with spills, and industry-based pollution. In effort to conduct a risk assessment on the potential for mining impacts on marine mammals, we combined field-collected data of the South American sea lion (Otaria byronia) rockery distribution, evidence of chemical pollutants found in stranded sea lions, and stranding occurrences in conjunction with existing datasets for the formal distribution of mines along the coast of Peru. In addition to overlapping these data, we used Esri aerial imagery (~1 meter resolution) data and SRTM (Shuttle Radar Topography Mission) 1-arc second (30 meter resolution) data to map and model any apparent topographic and ecological alterations along waterways that may serve as transferable sinks for mining-derived pollutants. The greatest potential for impacts on South American sea lions (Otaria byronia) come from mining waste and extractive activities in particular, which can result in the inhibition of their immune responses, and endocrine or stress impacts leading to degenerative diseases and reproductive disruption. This is an initial attempt at an overlap of extractive activities and marine mammal habitats being addressed for the Peruvian coast using remote sensing mapping and modelling.

Three is the charm! Dolphins prefer the three-way cooperative enrichment device over the two- and four-way ones  
Eszter Matrai¹, Rick Kwock², Michael Boos¹, Ákos Pogány⁴  
¹Ocean Park Hong Kong, Hong Kong, ²Ocean Park Hong Kong, Aberdeen, Hong Kong SAR, ³Ocean Park Hong Kong SAR, Hong Kong, Outside USA, China, ⁴Department of Ethology, Eötvös Loránd University, Budapest, Hungary

Alliance formation plays a crucial part of male dolphins’ life. Strong, first-order alliances may last for decades or even for a lifetime, thus partner choice and the maintenance of these relationships are both considered key components of alliance formation. In our previous investigations, pairs of adult male dolphins showed high success rate in cooperative manipulation of a cognitive enrichment device. Here we introduced two novel cognitive enrichment devices to the group of five dolphins, so that not only pairs, but three or even four dolphins could cooperate simultaneously. The devices were made of PVC tubes, fittings and caps equipped with rope handles, creating a three-way (T-shape) and a four-way (TT-shape) device. The devices were filled with fish and ice and designed to be opened by simultaneous pull of the handles. Both devices were tested on 12 trials (each lasted for 15min) separately. The devices had only one cap that could be opened, the position of this loose cap was counterbalanced over the trials. While the dolphins received no training regarding the manipulation
of the devices, they were successful on cooperatively opening the three-way devices on 10/12 trials (70% by two and 30% by three dolphins) and the four-way devices on 10/12 trials (50% by two, 40% by three and 10% by four dolphins). The dolphins interacted with the devices during the entire testing time, and this was mostly due to cooperative play (77% of the test duration with the three-way and 56% with the four-way device, significantly higher than with the earlier used two-way device, where cooperative play was recorded 33% of the test duration). These finding demonstrate the value of cooperative enrichments, promoting alliance formation and maintenance in male dolphins.

The impact of the "Anthropause" on the communication and acoustic habitat of Southeast Alaskan humpback whales
Leanna Matthews¹, Christine Gabriele², Samara Haver¹, Michelle E.H. Fournet⁴
¹Sound Science Research Collective, Juneau, AK, ²Glacier Bay National Park, Gustavus, AK, ³Oregon State University/CIMERS, ⁴Sound Science Research Collective

The COVID-19 pandemic caused profound changes in global human behavior, including substantial decreases in marine transportation, a pervasive ocean noise source. The human tragedy of the pandemic provides an unprecedented opportunity to investigate how humpback whales communicate in the absence of chronic noise common to their acoustic habitats. The Alaskan tourism industry was impacted particularly strongly; Southeast Alaska experienced a near complete absence of cruise ships during the 2020 tourism season (May - September), with a total absence of cruise ships in certain locations, including Glacier Bay National Park. In summer 2019 and 2020, we deployed a SoundTrap ST300 hydrophone in mid-Glacier Bay to document vessel-generated ambient noise and vocal characteristics of humpback whales (Megaptera novaeangliae), which have been studied in this region since the 1980s. Glacier Bay is unusual in that the number of vessels within the park is limited with little commercial activity beyond tourism, and speed limits are implemented through adaptive management strategies to minimize impacts on marine mammals. With dramatically lower vessel traffic, underwater noise was significantly lower in Glacier Bay compared to 2019. Median daily noise levels (dB_{RMS} 100-1500 Hz) were 3 times quieter during 2020 than in 2019 (mean difference 4.8 dB, 95% CI 2-7.5 dB) and daily maximum noise values (99th percentile daily noise values) were on average 25 times quieter during the pandemic than in 2019 (mean difference 14 dB, 95% CI. 11-17 dB). Initial analyses of humpback whale calling behavior show an increased number of call types in 2020 compared to the same period in 2019. Documenting humpback whale communication in quiet conditions can help illuminate impacts of chronic vessel noise and aid the development of measures to reduce human impacts in this and other marine protected areas.

Simulated marine vibroseis sounds disrupt feeding behavior of blue whales
Nina Maurer¹, Johannes Baltzer², Takashi Iwata¹, Tomonari Akamatsu¹, Klaus Lucke³, Marianne Helene Rasmussen⁵, Magnus Wahlberg⁵, Joseph Schnitzler⁴, Ursula Siebert⁶
¹Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Hannover, Germany, ²Ocean Policy Research Institute, the Sasakawa Peace Foundation, Minato, Tokyo, Japan, ³JASCO Applied Sciences, QLD, Australia, ⁴Húsavík Research Center, University of Iceland, Húsavík, ⁵Marine Biological Research Centre, University of Southern Denmark, Kerteminde, Funen,
Marine vibrators (MV) are considered to replace seismic air guns as a means for geophysical exploration due to their potential to reduce hearing impairments and behavioral disturbance effects for marine mammals. Signals emitted by MVs are transient, mostly low frequencies signals with lower sound pressure levels than seismic air gun impulses. However, their duration is longer than seismic air gun impulses and overlap with the communication frequency range of baleen whales. We conducted controlled exposure experiments with simulated MV signals on tagged blue whales (Balaenoptera musculus) in a feeding ground in Icelandic waters to investigate the potential effect of MV signals on their behavior. Low frequency sounds similar to those from MVs were generated via an underwater transducer (Argotec, SS-2). We analyzed tag data (Little Leonardo, ORI-400 D3GT; Star Oddi, DST Compass; Aquasound, AUSOMS micro) of four individuals in respect of short-term behavioral changes. The tags recorded fine scale movements and depth, as well as the received sound level at the animal, its vocalizations and temperature. By using these devices, we were able to correlate their dive profile and behavioral pattern before, during and after sound exposure. We found changes in surface time (< -2 m), post-dive duration and dive duration during exposure. Before the onset of the noise exposure, one tagged animal was recorded continuously lunging which indicates foraging, then temporarily displaying non-foraging dives with no detected lunges during exposure. These non-foraging dives within a feeding bout could be an indicator for feeding disruption due to MVs; prolonged behavioral disruptions in feeding grounds could lead to long-term consequences in vital activities. A decline in feeding effort is a critical factor for individual survival, influencing reproduction rates and affecting the population.

**Humpback whale singing activity before and during covid-19 lockdowns evidence the impact of small tour-boats.**

Laura J. May-Collado¹, Grance Durant, Sawyer Miller-Bottoms², Jose David Palacios-Alfaro³, Juan Jose Alvarado⁴, Betzi Perez⁵

¹University of Vermont, Burlington, VT, ²UNIVERSITY OF VERMONT, BURLINGTON, Vermont, ³Independent reseacher, San Jose, Costa Rica, ⁴Universidad de Costa Rica, San Pedro, San Jose, Costa Rica, ⁵McGill University / Panacetacea, Panama, Panama, Panama

The 2020 Covid-19 lockdowns provide a unique opportunity to study the impact of anthropogenic noise on marine mammal communication and their habitat. Here we study the singing activity of humpback whales Breeding Stock-G at Caño Island, Costa Rica. This area is also a major tourist destination. An autonomous underwater recorder was programmed to record the local soundscape for 10 minutes every hour at a sampling rate of 48 every day in September 2016, 2019, and 2020. A presence-absence matrix was generated for time-series analysis of boat and whale song detections. A 1-min sample for each hour was taken to measure noise levels in dB_{RMS} for 10 days each year. The results indicate a decline in boat presence and an increase in whale song detections in 2020. Noise levels in pre-covid years were higher at frequencies below 1 kHz while during the lockdown noise levels increased at frequencies used by humpback whales. Our results evidence the potential impact of small tour-boats in whale communication and it can inform efforts to regulate boat activity in humpback whale breeding habitat.
Ship strike risk from commercial vessels to migrating humpback whales (Megaptera novaeangliae) in Moreton Bay, Queensland.

Raphael Mayaud¹, Julian Castrillon², David Peel¹, Joshua Smith¹, Craig Wilson¹, Greta Dalle Luche², Jennifer Allen⁶, Susan Bengtson Nash⁷

¹The Southern Ocean Persistent Organic Pollutants Program, Griffith University, Brisbane, QLD, Australia, ²Griffith University, Nathan, QLD, Australia, ³Hobart, Australia, ⁴Murdoch University, Perth, Australia, ⁵Port of Brisbane Pty Ltd, Brisbane, Queensland, Australia, ⁶Griffith University, Moorooka, QLD, Australia, ⁷The Southern Ocean Persistent Organic Pollutants Program, Griffith University

The rapid recovery of the Australian humpback whale (Megaptera novaeangliae) population and parallel increase in maritime traffic, has increased the spatial overlap between whales and vessels in Australian waters. Ship strikes are a recognised global anthropogenic source of mortality or injury to large whales, and a potentially increasing risk in Australia. However, our understanding and evaluation of this threat to humpback whales around Australia, is hindered by the lack of seasonal whale distribution data in high marine traffic areas. Here we present four years (2017-2020 inclusive) of humpback whale distribution data and ship traffic data, and quantified the relative co-occurrence risk of ship strikes with migrating humpback whales in Moreton Bay. This marine embayment is home to Australia’s fastest growing container port: The Port of Brisbane. We estimated interannual ship strike risk by multiplying yearly predicted whale densities by the distance traversed by ships. Ship strike risk increased during the humpback whale’s southern migration (September-October), coinciding with a greater density of whales within this area. We also found that mother-calves were a predominant group in Moreton Bay during this time. Given their increased susceptibility to ship strikes, we suggest implementation of seasonal speed reductions are needed.

Summer Habitat Selection by Eastern Beaufort Sea Belugas in Relation to Grouping Behaviour

Alexandra Mayette¹, Marianne Marcoux², John Iacozza¹, Amelia Brower¹, Megan Ferguson³, Robert Suydam⁴, Lisa Loseto⁷

¹University of Manitoba, ²Fisheries and Oceans Canada, Winnipeg, Manitoba, ³University of Manitoba, Winnipeg, Manitoba, ⁴Joint Institute for the Study of the Atmosphere and Ocean Univ. of Washington, Alaska Fisheries Science Center NOAA, Seattle, WA, ⁵Alaska Fisheries Science Center/NOAA, Seattle, WA, ⁶North Slope Borough, Utqiagvik, AK, ⁷Fisheries and Oceans Canada/Freshwater Institute, Winnipeg, Manitoba

Habitat selection in odontocetes is affected by various environmental conditions and by sociality. Beluga whales (Delphinapterus leucas) are social animals due to their gregarious behaviour, extensive vocal repertoire, as well as cultural learning. The Eastern Beaufort Sea population is one of the most abundant in the world. Belugas spend the summer distributed across the Beaufort Sea and in July, thousands of belugas aggregate in the Mackenzie Estuary where the conditions are thought to attract whales for calving, moulding and protection. The summer distribution of the population spans different habitats and environmental conditions including water depth, temperature, and salinity. This study aims to describe the preferred habitat of single whales vs. groups. In 2019, two beluga aerial surveys were conducted in the Beaufort Sea, one by Fisheries and Oceans Canada in late July and one by the U.S. (NOAA and BOEM) in August. We used a resource selection function model with environmental variables including bathymetry, distance to shore, sea surface temperature, and chlorophyll-a, comparing individual whales and groups. The presence of calves in a group was also included in the model. A total of 383 belugas were observed in July (single individual: n = 217; groups: n = 65; groups with calves: n = 31) and 1061 belugas in
August (single individual: \( n = 456 \); groups: \( n = 151 \); groups with calves: \( n = 71 \)). We hypothesized that groups, especially those including calves, will be in shallow and warmer waters, where the conditions are more similar to those of the estuary, while single whales will be in deeper waters where feeding opportunities are better. This study aims to help better understand grouping behaviour and to manage the Eastern Beaufort Sea population, particularly in the two marine protected areas of the region.

**Habitat Partitioning Among Bottlenose Dolphin (Tursiops truncatus) Population Clusters in Roanoke Sound, North Carolina, USA**

Shauna McBride-Kebert\(^1\), Jessica Taylor\(^2\), Holly Fearnbach\(^3\)

\(^1\)Outer Banks Center for Dolphin Research, \(^2\)Outer Banks Center for Dolphin Research, Kill Devil Hills, North Carolina, \(^3\)SR3, SeaLife Response, Rehabilitation and Research, Seattle, WA

Information on home ranges and habitat partitioning among overlapping bottlenose dolphin \((Tursiops truncatus)\) communities can help inform population management and conservation. Multiple population clusters have been identified in a seasonally-occurring dolphin population in Roanoke Sound, an important nursery and foraging area in the northern Outer Banks of North Carolina. These population clusters exhibit different levels of site fidelity and they may represent distinct communities. The objective was to investigate the home ranges and habitat partitioning among population clusters in order to provide insight into community structure. Kernel density estimates were used to determine total range and core range (i.e., frequently used area) for population clusters and overlap of total ranges and core ranges was examined to determine habitat partitioning among population clusters. All population clusters exhibited extensive overlap in their total ranges. However, core range size and location varied across population clusters. The low site fidelity population cluster had a more dispersed core range throughout the estuary, while the high site fidelity population cluster had multiple core ranges in the central and southern regions including the estuary mouth. The differences in population cluster core ranges suggest that dolphins exhibit habitat partitioning of frequently used areas based on their site fidelity to Roanoke Sound. This result may be explained by population clusters exploiting different resources (e.g., prey species, foraging habitat) within Roanoke Sound. Certain population clusters may be more vulnerable to natural and anthropogenic disturbance events that impact estuary resources and require different management and conservation actions. This study provides new information on home ranges and habitat partitioning for dolphins from potentially distinct communities that rely on an important seasonal nursery and foraging area. Future aims of this study include investigating population cluster home ranges that extend beyond Roanoke Sound and examining population cluster habitat use to identify exploited resources.

**Genomic insights on the speciation of Berardius beaked whales**

Morgan McCarthy\(^1\), Morten Tange Olsen\(^2\), Michael Westbury\(^3\), John Gatesy\(^4\), Mark Springer\(^5\), Phillip Morin (he/him)\(^6\)

\(^1\)Globe Institute, University of Copenhagen, Copenhagen, Denmark, \(^2\)Institute of Biology, University of Copenhagen, Copenhagen Ø, Denmark, \(^3\)University of Copenhagen, Copenhagen, Denmark, \(^4\)Division of Vertebrate Zoology and Sackler Institute for Comparative Genomics, American Museum of Natural History, New York, NY, \(^5\)Department of Biology, University of California, Riverside, CA, \(^6\)Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, La Jolla, CA
The genus *Berardius* consists of three species; Arnoux’s beaked whale inhabiting the Southern Ocean and Baird’s and Sato’s beaked whales inhabiting the North Pacific Ocean. Despite occupying colder waters, all three species exhibit scarring from tropically distributed cookie-cutter sharks, suggesting far-ranging movements to the tropics. Previous *Berardius* phylogenies utilising limited regions of the mitochondrial genome and few nuclear markers gave important insights into the evolutionary relationships within this genus. However, genomic advances now allow us to study the speciation process far beyond simple bifurcating divergences. Here, we analyze whole mitochondrial and nuclear genomes to better understand the demographic and evolutionary history of *Berardius*. Inference of historical effective population sizes (Ne) indicates that all three had a sharply declining Ne from ~ 1.2 to ~ 1 mya. Sato’s beaked whale’s Ne steadily increased after 1 mya, while Baird’s and Arnoux’s beaked whales’ Ne increased during the Eemian warm period and following the LGM, respectively. Genome-wide comparisons support an initial divergence of Sato’s beaked whale from the Baird’s/Arnoux’s common ancestor ~ 6 mya, and a divergence between Baird’s and Arnoux’s beaked whales ~ 4.9 mya. Despite these deep divergence times, the most recent gene flow is inferred to have occurred between both Baird’s and Arnoux’s with Sato’s beaked whale ~ 0.6 mya, and between Baird’s and Arnoux’s beaked whales ~ 0.2 mya. The paraphyly of Baird’s and Sato’s beaked whales, despite inhabiting the North Pacific, together with the more recent gene flow between Baird’s and the southern hemisphere Arnoux’s beaked whale, is somewhat surprising. We propose that climate cycles during the late Pleistocene, coupled with ranging movements to the tropics, could have permitted repeated opportunities for gene flow between species prior to the Eemian warm period.

Data collected opportunistically aboard marine wildlife tourism vessels are an inexpensive source of spatial information on the target species. Although these data are often challenging to analyze, they can be used to monitor spatiotemporal changes in species distribution and behavior. Disruptions from whale-watching vessels to behaviors such as foraging can be particularly harmful to cetaceans, but impacts could be reduced if areas essential for these sensitive behaviors are identified. We used data collected onboard whale-watching vessels to explore space-use patterns in long-finned pilot whales (*Globicephala melas*) off northern Cape Breton Island, Canada, an area where tourism is essential. Encounters with pilot whales between 2011-2016 occurred twice as far offshore than during 2003-2006 and 2008, and foraging activity decreased. Despite the changes in distribution and activity budgets, we identified two hotspots of foraging activity that persisted through time. These identified foraging hotspots comprised only a small proportion (20 km²) of the range used by whale-watching vessels. Adaptive local management (e.g., voluntary codes of conduct) focused on limiting interactions in these energetically important areas may help reduce any potential impacts from whale-watching and promote the continued viability of the whale population and the tourism industry that relies on it.
Dolphins, Barnacles and Sharks: Use of photographs to examine intra- and inter-specific interactions in bottlenose dolphins in Mozambique.
Laura McConnell¹, Chloe Allen², Thomas Hunt³, Shaye Wettner², Diana Rocha³, Angie Gullan⁴, Sarah Marley⁷
¹University of Portsmouth, St. Albans, Hertfordshire, United Kingdom, ²University of Portsmouth, Portsmouth, Hampshire, United Kingdom, ³School of Environment, Geography and Geosciences - University of Portsmouth, Estoril, Lisbon, Portugal, ⁴Dolphin Encounters Research Center, Maputo, Mozambique, ⁵Scotland’s Rural College (SRUC), Portsmouth, Hampshire, United Kingdom

Understanding interactions both within (intra-specific) and between (inter-specific) species is crucial to ecological research. However, for marine mammals such interactions can be difficult to observe in the field due to challenges imposed by species characteristics, environmental conditions, and logistical constraints. Photographs offer an opportunity to study intra- and inter-specific interactions, by capturing ‘snapshots’ of their occurrence over space and time. A long-term photographic-identification catalogue of over 200 bottlenose dolphins (Tursiops aduncus) inhabiting Ponta do Ouro, Mozambique was used to examine evidence of interactions with other dolphins (tooth rake scars), ectoparasites (barnacles), and predators (shark bites). Significant differences in intra-specific scarring levels existed according to both sex and age class. Male dolphins exhibited higher levels of tooth rake scarring than females in terms of number of rake directions, scarring percentage, and nick percentage; similarly, adult dolphins exhibited higher levels of scarring than juveniles or calves. The presence of barnacles on dolphins showed strong seasonal trends, which were closely associated with sea surface temperature. Barnacle presence also significantly varied according to dolphin body area, with some areas (i.e., fluke, dorsal and pectoral fins) being particularly prone to infestation. Shark bites showed significant differences in their distribution across the dolphin body areas, with the dorsal side being more frequently wounded than the ventral side. However, the severity of shark bite wounds did not vary according to dolphin body area. Overall, this study demonstrates the utility of photographs for examining ecological interactions. It provides the first insights regarding dolphin social behaviour, health, and predation risk for this population. These in turn will support future research into the population dynamics and conservation of the Ponta Do Ouro dolphins, which is urgently required in the face of increasing anthropogenic pressures in this area.

Inferring presence of cetaceans using soundscape metrics in Australian Marine Parks
Jessica McCordic¹, Annamaria DeAngelis², Logan Kline³, Candace McBride³, Giverny Rodgers⁴, Timothy J. Rowell¹, Jeremy Smith⁴, Jenni Stanley⁵, Allison Stokoe⁶, Sofie Van Parijs⁷

In marine protected areas, conservation efforts based on soundscape monitoring specifically focus on assessing the relative influence of anthropogenic and biological sounds. Australian Marine Parks represent a large network of marine protected areas with diverse conservation and management goals. Measuring the underwater soundscapes of these parks offers a standardized way to establish baseline acoustic conditions and identify which sounds are prevalent enough to contribute to monitoring ecosystem health over time. We deployed acoustic recorders in three Australian Marine Parks—Cod Grounds Marine
Park (three deployments, range 35 – 71 days per deployment), Solitary Islands Marine Park (three deployments, range 33 – 60 days per deployment), and Ningaloo Reef Marine Park (one deployment, 53 days)—which represent known habitat of multiple cetacean species, including humpback whales (*Megaptera novaeangliae*), dwarf minke whales (*Balaenoptera acutorostrata*), southern right whales (*Eubalaena australis*), blue whales (*Balaenoptera musculus*), and oceanic dolphins (*Dephinidae spp.*). All acoustic data were manually reviewed for hourly presence of baleen whale calls and additional sound sources identified during preliminary analyses: vessel passages, fish chorusing, and snapping shrimp. Dolphin whistles were detected using a combination of manual review and automated detection. Hourly presence of all sound sources was compared to broadband soundscape metrics taken at the scale of an entire deployment to determine which sources are identifiable in these metrics. Based on the relative contributions of each sound source to the overall soundscape, we provide recommendations on the suitability of using soundscape metrics to remotely monitor marine mammal presence in each of the parks.

**Relationship Between Mercury and Selenium Concentrations and Selenium:Mercury Molar Ratios in Tissues From Stranded Bottlenose Dolphins (Tursiops truncatus) in the Northern Gulf of Mexico**

Meaghan McCormack1, Brian P. Jackson2, Jessica Dutton3

1Texas State University, 2Department of Earth Sciences, Dartmouth College, Hanover, NH 03755, 3Department of Biology, Texas State University, Aquatic Station, San Marcos, TX 78666

Dolphins can accumulate mercury (Hg) to high concentrations in their tissues but show few signs of Hg toxicity. Mercury can bind to selenium (Se) forming toxicologically inert mercury selenide (HgSe) compounds, which may mitigate some of the toxic effects of Hg exposure in dolphins. To explore the accumulation of Hg and Se and the relationship between the two elements, we measured the concentrations of total Hg (THg) and Se and calculated the Se:Hg molar ratios in five tissues (blubber, kidney, liver, lung, skin) from bottlenose dolphins (*Tursiops truncatus*) that stranded along the coast of Florida (FL; n = 52) and Louisiana (LA; n = 41). For FL and LA combined, mean THg concentrations (µg/g dry wt) were greatest in the liver followed by the kidney, lung, skin, and blubber, and mean Se concentrations (µg/g dry wt) were greatest in the liver followed by the kidney, skin, lung, and blubber. After accounting for body length, condition code, and sex, on average, dolphins that stranded in FL had greater liver, lung, and kidney THg and Se concentrations than dolphins that stranded in LA. Blubber and skin samples were only available for FL. In all tissues, THg concentration and Se concentration were positively correlated. Although mean Se:Hg molar ratios were approximately 1:1 in the liver and >1:1 in the other four tissues, they decreased with increasing THg concentrations, and some individual Se:Hg molar ratios were < 1:1. Dolphins from FL had lower mean Se:Hg molar ratios than dolphins from LA. Our results suggest that Se protects against Hg toxicity in bottlenose dolphins inhabiting the northern Gulf of Mexico. However, spatial variability in THg and Se concentrations, and Se:Hg molar ratios observed among bottlenose dolphins suggests that Hg accumulation may differ across habitats and certain stocks may be at greater risk of Hg toxicity.

**Molecular mechanisms underlying response to influenza in gray seals, a potential wild reservoir**

Christina McCosker1, Ebru Unal2, Alayna Hawkins3, Wendy Puryear4, Jonathan Runstaedler5, Kristina Cammen1
Influenza A virus (IAV) is responsible for multiple unusual mortality events involving pinnipeds throughout the North Atlantic, but disproportionately affects different species. Gray seals (*Halichoerus grypus*) appear to be less susceptible to IAV infection compared to harbor seals (*Phoca vitulina*) as evidenced by differences in morbidity and mortality rates during IAV outbreaks. The subclinical nature of IAV infection in addition to life history and ecological factors suggest that gray seals are a potential wild reservoir host for IAV. We investigated differential gene expression (DGE) among gray seals in different stages of IAV infection to elucidate underlying genetic mechanisms involved in gray seal disease resistance. RNA sequencing was conducted on blood samples (*N* = 31) collected from gray seal pups on Monomoy and Muskeget Islands in Massachusetts, U.S. between 2014 and 2019. Samples were categorized to disease stage (acute, peak, late, control) based on presence/absence of viral RNA and antibodies. A combination of genome-guided and *de novo* transcriptome assembly approaches were used with all samples to generate a gray seal blood transcriptome. Female gray seal samples (*N* = 27) were selected for a DGE analysis in which RNA sequence reads were aligned to the *de novo* transcriptome. The final transcriptome assembly contained a total of 161,131 transcripts and 31,879 gene clusters that were analyzed for DGE in edgeR after filtering. Differentially expressed genes were identified in each pairwise comparison of disease stages, including 10 genes clusters found in all pairwise comparisons of infected individuals with control samples. Further investigations of the function of these differentially expressed genes will increase our understanding of the genetic underpinnings of disease response in a potential wild reservoir and will contribute to a growing body of knowledge on evolutionary differences between two sympatric pinnipeds.

**Acoustic classification of false killer whales in the Hawaiian Islands based on comprehensive vocal repertoire**

Jennifer McCullough¹, Anne Simonis², Taiki Sakai³, Erin Oleson⁴

¹NOAA-PIFSC, Honolulu, HI, ²NOAA National Marine Fisheries, San Francisco, California, ³NMFS/NOAA SWFSC, Environmental Assessment Services LLC, Newport Coast, CA, ⁴NOAA NMFS Pacific Islands Fisheries Science Center, Honolulu, Hawaii

Underwater passive acoustic recordings can be valuable tools for monitoring protected species; however, robust classification systems are needed to identify encounters to the species-level. Towed hydrophone array acoustic recordings were collected as part of the Hawaiian Islands Cetacean and Ecosystem Assessment Survey (HICEAS) in 2017. This large-scale survey took place July–December using two research vessels, which systematically surveyed the Hawaiian Exclusive Economic Zone (EEZ). A suite of routines designed to efficiently detect cetacean sounds (PAMGuard), extract features (PAMpal), and classify the detection to species (banter) is described using visually-verified detections of false killer whales (*Pseudorca crassidens*) collected during the HICEAS effort. We evaluated models trained on multiple potential species labels (e.g., false killer whales (PC), sperm whales, rough-toothed dolphins), as well as a two-case scenario where all species besides false killer whales were considered under an aggregated label “OTHER.” Both models included features from clicks, whistles, and burst pulses. The multi-species model produced a 100% correct classification rate for PC but with an 82.96% overall correct classification across all species, including some species encounters.
incorrectly classified as PC. The best performing model was the two-case model producing a 99.57% overall correct classification. Both models were then applied to visually-verified detections of false killer whales to examine performance during other data collection efforts, including winter surveys in Hawaii in 2019–2020. This case study illustrates use of these tools to build classifiers for any group of cetacean species and assess classification confidence when visual confirmation is not available. All of the detection, feature extraction, and classification tools are open-source, and the methods we demonstrate here can easily be applied to other regions, taxa, and call types.

**Growth patterns and the effect of acidification on postcranial vibrissae in Florida manatees (Trichechus manatus latirostris)**

*Isabella McDonnell*¹, *Athena Rycyk*²

¹New College of Florida, Mount Prospect, IL, ²New College of Florida, Sarasota, Florida

Florida manatees (Trichechus manatus latirostris) possess highly sensitive vibrissae across the surface of their body. These structures enable manatees to detect water flow and the changes in water flow that may result from the presence of nearby objects such as other manatees. This project examined vibrissae growth rate and possible effects a changing environment may have on these structures. We monitored 40 vibrissae follicles on two captive Florida manatees over ten weeks and experimentally manipulated pH levels in tanks that contained trimmed vibrissae. To understand growth, vibrissae length at each follicle was measured periodically and mean growth rate was found to be 0.64 mm per day across manatees and the mean vibrissae length across manatees was 7.22mm. In order to study the possible effects of ocean acidification, 40 vibrissae were trimmed and randomly assigned a tank with a pH value of 7.95, 8.05, 8.15, 8.25 (a typical value for their natural environment), or 5.60 (deionized water). They were studied after 7 weeks and again after 9 additional weeks. Different visual characteristics were used to classify changes of the vibrissae when viewed under a compound microscope including transparency changes, roughness of the surface of the vibrissae, and bends in the vibrissae. The vibrissae left in water with a pH of 8.25 had the lowest level of changes, while those in water with a pH of 5.60 had the most physical changes, followed by the vibrissae in the most acidic water. Future research to understand if these physical changes in the vibrissae alter the functionality of their hydrodynamic sense would help predict the impact ocean acidification may have on Florida manatees.

**Variation in Hawaiian Spinner Dolphin (Stenella longirostris) Daytime Habitat-Use During Restricted Commercial Boating Activities in Response to the COVID-19 Pandemic**


¹Hawai‘i Institute of Marine Biology, University of Hawai‘i at Mānoa, ²Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, Hawai‘i, ³Hawaiian Islands Humpback Whale National Marine Sanctuary, Kihei, HI, ⁴University of Hawaii at Hilo, Hilo, Hawaii

Within the Hawaiian Islands, the Kona coast of Hawai‘i Island and Wai‘anae coast of O‘ahu are important daytime resting habitats for the Hawaiian spinner dolphin (Stenella longirostris) and highly targeted by the public and commercial swim-with-dolphin tour operators. The frequent interaction between people and spinner dolphins raises concern for the potential disturbance of their crucial resting behavior. At the onset of the COVID-19 pandemic, the Hawai‘i Division of Boating and Ocean Recreation (DOBOR) banned all commercial boating operations from March 18, 2020 through June 3, 2020 with subsequent restrictions on vessel capacity. These restrictions
provided a unique opportunity to explore spinner dolphin habitat-use patterns during a period of reduced pressure from tourism using two methods: shore-based visual surveys, and passive acoustic monitoring. Shore-based surveys were conducted at Mākua Beach on the Wai‘anae coast from June 30 – August 4, 2020 and November 22 – December 05, 2020, during which commercial boating operations were limited to 50% capacity. From 08:00 h – 14:00 h, three times weekly, vessels, human swimmers, and spinner dolphin activities were recorded. Results indicated that on average, fewer spinner dolphins were present when more human swimmers were in the bay, and more dolphins were present when there were fewer swimmers. Daytime passive acoustic recordings in Kealakekua Bay collected in April 2020 were analyzed for the presence of spinner dolphin acoustic signals. Variation in these signals were analyzed to determine the daily rate of occurrence of spinner dolphins at the monitored resting locations, as well as the residency time of spinner dolphins at each location before and after the implementation of the DOBOR restrictions. These analyses of the impact of human activities on spinner dolphin behavior provide a unique opportunity to inform management decisions moving forward.

**Female mate choice despite allied sexual coercion in Indo-Pacific bottlenose dolphins**

Molly McEntee¹, Vivienne Foroughirad², Ewa Krzyszczyk¹, Alexis Levengood³, Eric Patterson⁴, Megan Wallen³, Céline Frère⁶, Janet Mann⁷

¹Georgetown university, WASHINGTON, DISTRICT OF COLUMBIA, ²Georgetown University, MOREHEAD CITY, North Carolina, ³University of the Sunshine Coast, East Stroudsburg, Pennsylvania, ⁴Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, SILVER SPRING, Maryland, ⁵NOAA Fisheries, Washington, District of Columbia, ⁶University of the Sunshine Coast, Sippy Downs, Queensland, Australia, ⁷Georgetown University, Washington, DC

In sexually coercive mating systems, males use aggression and mate guarding to induce females to mate and to prevent females from mating with other males. The degree to which these coercive strategies limit or prevent female mate choice, however, is debated. Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) are a compelling system for investigating how female mate choice and male coercion interact. Male dolphins form long-term alliances to harass and mate guard females. Females invest substantially in each offspring; gestation lasts one year and lactation lasts three to eight years with males contributing little beyond sperm. Females could be under strong selection pressure to maximize the genetic fitness of each offspring via mate choice. Here, we integrate 35+ years of fine-scale longitudinal behavioral observations and genetic data from a population of Indo-Pacific bottlenose dolphins in Shark Bay, Australia, to investigate the role of female mate choice within a coercive mating system. Results from a GLMM (N = 70 paternities) suggest that male age, home range overlap, and previous social association (simple ratio index), but not relatedness to the female impact the likelihood of paternity. Middle-aged (age 20 - 35) males who are local to and socially associated with a female are more likely to sire her offspring. Additionally, paternity is not distributed randomly within an alliance: males who sire offspring have stronger associations with the maternal female than their alliance partners do (permutation tests). Females may be limited in their ability to control which alliance guards them at the time of conception but could exercise control over which male within an alliance obtains paternity. While females plausibly benefit by mating with local, socially associated males to reduce infanticide risk, this could also increase inbreeding. Our results suggest that female mate choice may be an important counterstrategy to male coercion in
this system.

**Linking natural history to vital rate estimation in an endangered whale: could a shortened reproductive lifespan be hindering recovery in Cook Inlet belugas?**

**Tamara McGuire**, Gina Himes Boor, Amber Stephens, John McClung, Christopher Garner, Kim Shelden, Caroline Goertz, Kathleen Burek-Huntington, Greg O'Corry-Crowe, Bruce Wright

1Aqua Wildlife Research, Anchorage, AK, 2Montana State University, Bozeman, Montana, 3The Cook Inlet Beluga Whale Project, 4The Cook Inlet Beluga Whale Photo-ID Project, 5Anchorage, Alaska, 63Joint Base Elmendorf Richardson, U. S. Air Force. Conservation, 7JBER, AK, 8Alaska Fisheries Science Center, 9Seattle, Washington, 10Alaska SeaLife Center, 11Seward, AK, 12Alaska Veterinary Pathology Services, 13Eagle River, AK, 14Florida Atlantic University, 15Knik Tribe, Palmer, AK

Alaska’s endangered Cook Inlet belugas (CIBW; *Delphinapterus leucas*) remain in decline for unknown reasons. Understanding of CIBW population dynamics and the appropriate actions needed for their recovery is hindered by a lack of information on basic natural history and vital rates. We combined sighting and reproduction data of ~420 photo-identified individuals obtained from ~400 surveys conducted 2005-2017 with biological data from 95 strandings. We identified the CIBW calving period as July-October, with inter-birth intervals from 2-13 years (3-5 year intervals most common). Calves photographed alongside their mothers were 1-8 years old, although most were ≤4 years. The youngest mothers were 10-13 years old, suggesting first reproduction in CIBW females may be somewhat delayed compared to other populations (e.g., 8-9 years old). Reported mortality was greatest for adults, followed by calves, with fewer subadults. Adults were dying in their reproductive years (mean age adult death in mid-20s), with no adults older than 49 years in the stranding data, despite lifespans of 70+ years reported in other populations. Dead females and males were evenly represented, although adult males were younger than adult females. Live stranding was the predominant assigned cause of death, but only represented ~33% of deaths of known cause. The cause(s) of most deaths and live strandings were undetermined. Estimates of annual mortality from reported carcasses averaged 2.2% of total population size, and underestimate true mortality. The patterns we document give critical insight into the population’s natural history and indicate that it may be experiencing a shortened reproductive lifespan. These data and the natural history patterns they reveal are foundational to our ongoing work to use statistical models to estimate demographic rates and long-term viability. These, in turn, should guide investigations into causal mechanisms, and inform recovery actions and management decisions.

**Enhanced monitoring of adverse human-dolphin interaction hotspots via continuous multi-view video and passive acoustic technology**

**Katherine McHugh**, Rene Byrskov, Shelbourne Brown, Gabriela Hernandez Ramirez, Victoria Diaz, David Mann, O. Jacob Isaac-Lowry, Sarah C. Alessi, Randall Wells

1Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, Florida, 2Sarasota Dolphin Research Program, Odense C, Denmark, 3Scottish Oceans Institute, University of St Andrews, 4Loggerhead Instruments, Inc., Sarasota, FL, 5FlyWire Cameras, Lexington, KY

Bottlenose dolphins near Sarasota Bay, Florida experience a suite of adverse human interactions (HI). Injuries from recreational fishing gear and unnatural foraging behaviors focused on anglers’ bait and catch became elevated in the mid-2000s,
and sustained problems have necessitated several research and outreach efforts to better understand and mitigate HI. In addition to fisheries interactions, inshore dolphins in this region face high levels of recreational boat traffic with frequent disturbance from close approaches and boat-based viewing activities. Dedicated sampling at identified HI hotspots, including remote monitoring via deployment of passive acoustic and multi-view video systems, can provide comprehensive interaction data to more efficiently target educational outreach and enforcement efforts. Here we provide results from a test at two shore-based sites with frequent HI: 1) a Gulf fishing pier where dolphins commonly scavenge and depredate from anglers (video only) and 2) a bayside canal where dolphins are frequently harassed by boaters (video + acoustics). We deployed solar-powered multi-camera systems at each site, which recorded for up to 12 hours per day with a combined 290-degree field of view allowing us to capture presence of dolphins, fishers, vessels, and HI events during most daylight hours for a robust assessment of HI rates. Four cameras were initially deployed at each site for 5 days to provide broad coverage, followed by an additional 10 days focused only on the two cameras providing the most detail. Videos were reviewed by multiple observers to identify and confirm HI events and evaluate compliance with viewing guidelines. At the canal location, new educational signage was deployed midway through the trial, allowing us to evaluate changes in compliance without human observers potentially affecting boater actions. Overall, remote monitoring systems provided enhanced capacity at a low upfront cost, but video review was very time consuming.

Coping with change: the influence of prey availability on behavioral decisions and reproductive success of a central place forager during lactation

Elizabeth McHuron¹, Jeremy Sterling², Marc Mangel³

¹University of Washington, Seattle, Washington, ²Marine Mammal Laboratory, Alaska Fisheries Science Center/NOAA, Seattle, WA, ³Santa Cruz

Marine mammals are increasingly faced with a changing prey environment that may impact their foraging behavior, reproductive success, and population dynamics. We explored the influence of changes in prey distribution and abundance on the behavior and reproductive success of a central place forager during lactation using state-dependent behavioral life history theory implemented via stochastic dynamic programming (SDP). We used northern fur seals (Callorhinus ursinus) as our motivating species given the ongoing population decline of the Eastern Pacific Stock and projected warming in the eastern Bering Sea. We also explored how physiological and morphological variation present within the otariid lineage affected model output. Females adopted a central place foraging strategy after an initial extended period spent on land (4.7 - 8.3 days), except for scenarios when the prey patch was too far from the rookery, which led to immediate weaning. Trip durations increased as the prey patch moved farther from the rookery or when the energy density of the prey patch decreased. Increases in trip durations adversely affected pup growth rates despite attempts to compensate by increasing shore durations. Metabolic rate adaptations had the largest impacts on pup wean mass; reductions in a pup’s metabolic rate allowed females to successfully forage at distances up to 619 km from the rookery for up to 15+ days. Our results indicate that, without physiological adaptations, a rookery is unlikely to be viable if a female northern fur seal has to consistently travel 400+ km or farther to reach the primary foraging grounds. To achieve pup growth rates observed on Bogoslof Island, where the northern fur seal population has exhibited rapid population growth, model results indicate the primary foraging grounds need to be <150 km from the rookery.
Blue Water Transients: Ecology of Mammal-Hunting Killer Whales off the Outer Coast and Offshore Waters of California and Oregon

Josh McInnes¹, Chelsea Mathieson², Andrew W. Trites³, Peggy West-Stap⁴, Stephanie Marcos⁴, Paula Olson⁵, Victoria Wade⁴

¹University of British Columbia, Marine Mammal Research Unit, Victoria, British Columbia, ²Transient Killer Whale Research Project, Victoria, British Columbia, ³UBC Marine Mammal Research Unit, Vancouver, British Columbia, ⁴Marine Life Studies, Moss Landing, California, ⁵Southwest Fisheries Science Center, National Oceanic and Atmospheric Administration, La Jolla, California, United Kingdom

The west coast (WC) transient killer whale (Orcinus orca) population is widely distributed in the coastal inland waters of Washington State, British Columbia and Southeastern Alaska, but less is known regarding their population structure and ecology on the outer coast and offshore waters South of Washington State. Using photographs of transient killer whales taken in the offshore and outer coasts of Oregon and California during 146 different occasions between 2006-2018, we identified 155 unique individuals, of which 150 are considered to be alive (as of 2018). These included 3 adult males, 51 adult females, 24 sub-adults, and 41 juveniles, belonging to 30 matrilineal groups. We predominantly encountered this population of transients off the outer coast near the continental shelf break, or in deep pelagic waters overlying the Monterey Submarine Canyon. Although killer whales were documented all year, the majority of encounters occurred during the spring (March through June) and fall (September through November) in Monterey Bay, California (due to high observer effort). Observations of predation involved several species of marine mammal, of which California sea lions (Zalophus californianus) were the predominant prey, making up 46% of observations. Gray whale (Eschrichtius robustus) calves accounted for 23% of predation events, but were only observed as prey during the spring, coinciding with the annual northbound Gray whale migration. The vast majority (>83%) of whales could not be matched to transient killer whales photo-identified in the coastal waters of the Pacific Northwest. These two factors (habitat differences and low match rate) suggest that this is a putative outer coast assemblage of killer whales within the WC transient population.

Is There Any Rhyme or Reason to Tipping on whale watch boats?

Cynde McInnis, The Whalemobile, Topsfield, Massachusetts

Whale and dolphin watching expeditions are an exciting way for tourists to go out and see these amazing animals. Until about ten years ago, passengers in Gloucester, MA rarely tipped the crew when leaving the boat. That has changed over the years and now it’s customary to tip the crew. Having worked on boats for over 20 years, I find that the amount that is collected each trip puzzling. Days when we think the tips will be high, they are low, and visa versa. Is there any rhyme or reason to tipping? This project will compare the amount of tips collected at the end of each trip to various aspects of the trip itself: number and species of whales, weather, behaviors, and particular crew members to name a few. Could this information give us any insight into moving these passengers into conservationists? Through interviews, and surveys, we will explore this question. Inspiring connection and conserving these animals is the ultimate goal. The more we know about the people whale watching and their motivation for where their money is going, the more we can tailor their experience to achieve our goal.

The status of marine mammal research in Macaronesia: are we doing enough?
Despite their ecological importance, many species of marine mammals are of high conservation concern due to anthropogenic impacts. Marine mammals may encounter various levels of protection and anthropogenic exposure across jurisdictions due to their highly migratory nature. Successful conservation is often dependent on population-level information to which bibliographic reviews can identify knowledge gaps to help guide conservation efforts. We implemented a systematic review to quantify and describe current research trends of key megafauna groups, emphasising marine mammal research among the archipelagos of Macaronesia (NE Atlantic). The initial search criteria produced 815 peer-reviewed articles, screening procedures deemed 438 suitable and found 402 articles relevant for analysis. Reviewed literature was published between 1968 and February 2021, with the number of published articles significantly increasing through time ($R^2 = 0.82$; $p < 0.001$). Overall, studies that specifically focused on marine mammals represented 49% of all marine megafauna research in Macaronesia (96% cetacean; 4% pinniped). Studies on marine mammals were predominantly carried out in the Azores (41%), followed by the Canary Islands (35%), Madeira (15%), and Cabo Verde (9%). Only 3% of these studies incorporated data from more than one archipelago in their analysis. The majority of marine mammal studies focused on biodiversity and biogeography (17%), followed by pathological (16%) and behavioural (15%) research. The most common methodological approaches were in-situ observations (50%) and tissue sampling (36%). Only a few of the studies (19%) quantified anthropogenic impacts.

Although most regional marine megafauna research has been conducted on marine mammals, our findings reveal an uneven distribution in information among archipelagos and research disciplines. Our results highlight the need for inter-archipelago research for highly mobile species. We suggest a greater research focus on quantifying region-specific anthropogenic threats and identifying areas of increased risk as a first step in establishing conservation priorities for marine mammals across Macaronesia.

**Assessing the exposure of North Atlantic right whales (Eubalaena glacialis) to vessel traffic**

Katherine McKenna1, Laura Ganley2, Jeff Adams3, Caroline Good4, Eric Patterson5, Daniel Pendleton6, Jessica Redfern6

1Anderson Cabot Center for Ocean Life at the New England Aquarium, 2Burlington, Massachusetts, 3NOAA, Fisheries, Silver Spring, Maryland, 4NOAA - Office of Protected Resources, Silver Spring, MD, 5Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, SILVER SPRING, Maryland, 6Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, Massachusetts

Vessel strikes are one of the most severe threats to large whales worldwide. Exposure of whales to vessels can also cause increased stress, acoustic masking, and behavioral changes. Spatially explicit whale distributions are not available in many parts of the world, making it difficult to assess vessel impacts. We develop a metric to assess “exposure” of whales to vessel traffic that only requires whale sightings and vessel locations. We apply this method to the critically endangered North Atlantic right whale...
(Eubalaena glacialis), which migrates along the east coast of the United States and Canada through areas with extensive vessel traffic. Management strategies to reduce the threat of vessel strike have had mixed results and right whales continue to experience mortality and injuries from vessels. We used AIS vessel traffic data and 4691 right whale sightings to assess exposure. Specifically, we measured the distance to the closest passing vessel within a range of time periods before and after each right whale sighting. We summarized exposure levels by vessel type, vessel speed, the amount of time between the sighting and the closest approach, and geography. We found that vessels occurred close to right whales (e.g., mean distance within a +/- 48 hour window = 2.8 km) and that these vessels were traveling at a range of speeds (e.g., vessel speeds ranged from 2.5 knots to 36.5 knots in a +/- 48 hour window). Right whales in the northeast had high exposure to fishing vessels while right whales in the mid-Atlantic and southeast were more frequently exposed to large ocean-going vessels. This method represents a simple and effective means of identifying strategies to mitigate vessel strikes and reduce sub-lethal vessel impacts to whales worldwide.

Environmental Drivers, Distribution and Population Density of Harbour Porpoises in Southern Cornwall Using Visual and Acoustic Survey Data
Hayley McLennan¹, Clare Embling²
¹Bristol, United Kingdom, ²Plymouth University, Plymouth, United Kingdom

Harbour porpoises (Phocoena phocoena) are small cetaceans with a wide distribution across the UK. The south of Cornwall is an understudied region concerning this species, with historically conflicting estimates of population abundance. It is also a region in which P. phocoena is at high risk of mortality through bycatch in gill nets. This study uses 18 days of visual and acoustic data from surveys performed in August 2017, August 2018, and June-July 2019 to create habitat models of harbour porpoise occurrence in coastal southern Cornwall. These were used to estimate population abundance, identify environmental drivers of porpoise distribution, and create predictive maps of porpoise occurrence across the study area. Sea surface temperature (SST), distance from coast, and depth were related to porpoise presence/absence. Both the visual and acoustic models predict a higher likelihood of porpoise presence in shallower near-coast parts of the survey area, and where there were warmer SSTs, up to a peak in probability around 17.5°C. Distance sampling of acoustic detections was used to estimate P. phocoena abundance/density for each survey. This indicated seasonal variation in the population with a higher density found during the August surveys than the June-July survey. The estimated densities from the August surveys were 0.36 individuals/km in 2017, and 0.31 individuals/km in 2018. These are comparable to those from the SCANS-II survey in July 2005 within Special Areas of Conservation (SACs) in the same management unit (MU). Overall, this study highlights the value of using both visual and acoustic methods to study P. phocoena. The results show a seasonal high density of P. phocoena in south Cornwall, with their distribution favouring shallow coastal areas and warmer SST. These results support implementing strong protective measures for harbour porpoises in this region and provide evidence for where and when these would be most effective.

Combining survey and tagging data to inform humpback whale vulnerability to vessel strikes in a high-traffic shipping area
Christie McMillan¹, John Calambokidis², James Fahlbusch³, Elise Keppel¹, Lisa Spaven⁴, Thomas Doniol-Valcroze⁵
¹Fisheries and Oceans Canada, Vancouver, BC, ²Cascadia Research Collective, Olympia, ³Stanford University, Cascadia Research
Effective management of anthropogenic threats to cetacean populations requires information on their spatial and temporal patterns of habitat use and behaviour. The number of humpback whales in Juan de Fuca Strait, between British Columbia, Canada and Washington State, U.S., has increased considerably in recent years. Concurrently, plans for development projects are expected to significantly increase shipping traffic in this region. We combined two methods to assess the vulnerability of humpback whales to vessel strikes in and around the shipping lanes of Juan de Fuca Strait. Data from monthly boat-based line-transect surveys were used in a species distribution modelling approach to predict seasonal areas of high humpback whale density. In addition, medium-duration archival tags were deployed on ten humpback whales in 2018-2020, resulting in over 360 hours of high-resolution dive and movement data. All tagged individuals exhibited foraging activity within an area of high humpback whale density in central Juan de Fuca Strait. Feeding behaviour primarily consisted of deep foraging dives to depths of 180-200 m, with more feeding occurring in the afternoon and evening than in the morning. Tagged whales spent higher proportions of time in the upper portion of the water column late overnight and into the morning; thus humpback whales may be more vulnerable to vessel strikes during these hours. Combining predictions of whale density on a broader spatial scale with fine-scale movement and dive behaviour analyses provides insight into vessel strike risk that neither method alone can achieve. Mitigation measures should take into account both the seasonal distribution and behaviour of humpback whales in order to maximize potential effectiveness.

Helping people connect with charismatic megafauna, like dolphins, can help overcome the challenge of motivating the public to take interest in protecting the environment. Different aspects of dolphins may appeal to different people. For example, some people may value watching demonstrations of their natural athleticism, while others take interest in interacting with them directly. Many people are impressed by their intelligence, so here at Dolphin Research Center we choose to emphasize their cognitive abilities. We highlight research throughout the day by incorporating the following into public narrations:

- Demonstrating current and published cognitive research.
- Showcasing thinking games and concept behaviors, including an interactive program which incorporates them.
- Highlighting behavioral research, including ways for guests to take their own informal observations.
- Discussing field research, including interactive ways for guests to experience photo-ID with the dolphins at our facility.

To maximize our impact, we believe it is important to utilize every way possible to connect people with the animals. This connection translates to motivation to care for the species and the environment in which they live.
A whale’s guide to stress management: application of corticosteroid hormones as biomarkers for stress response

Valentina Melica¹, Shannon Atkinson DeMaster², Diane Gendron¹, Aimee Lang⁵, Jonathan Scordino¹, John Calambokidis⁶
¹University of Alaska Fairbanks, College of Fisheries and Ocean Sciences, Juneau, AK, ²University of Alaska Fairbanks, ³CICIMAR - IPN, La Paz B.C.S., ⁴NMFS, Southwest Fisheries Science Center, La Jolla, California, ⁵Makah Fisheries Management, Makah Tribe, Neah Bay, WA, ⁶Cascadia Research Collective, Olympia

The goal of this study was to provide a comprehensive analytical and biological validation of three corticosteroid hormones as biomarkers of physiological stress response of blue (Balaenoptera musculus) and gray (Eschrichtius robustus) whales from the Eastern North Pacific. Hormones were extracted from blubber samples from 78 live and 3 stranded blue whales and 108 live and 35 stranded gray whales and analyzed for cortisol, corticosterone and aldosterone using commercially available enzyme immunoassays kits. Analytical validations (i.e., parallelism and accuracy tests) were used to determine detectability and measurement accuracy of these hormones. Then, a two-step biological validation was carried out (1) testing hormone concentrations in response to life history parameters in “healthy” (biopsies) whales (e.g., sex, age class, reproductive state), and (2) comparing “healthy” and “stressed” (stranded) animals. All corticosteroid assays passed the analytical validations. In “healthy” blue whales, corticosterone was significantly lower in immature female than in pregnant (p=0.05) and lactating (p=0.02) whales. In “healthy” gray whales, pregnant females had significantly lower cortisol than lactating whales (p=0.01). Stranded blue whales had higher corticosterone than “healthy” individuals. In gray whales, concentrations of cortisol and corticosterone, but not aldosterone were significantly higher in “stressed” than in “healthy” animals.

Additionally, cortisol concentrations were affected by the cause of death in gray whales, with animals that perished from trauma (e.g., ship-strike) or from nutritional stress showing elevated hormone concentrations (p=0.003) as opposed to whales that died from entanglement or hunted by predators. This study provides evidence that endocrine biomarkers are likely sex- and species-specific in large whales and are affected by reproduction. With the increasing interest in developing markers for monitoring wildlife stress response, the analysis of multiple hormones provides a more comprehensive understanding of the physiological processes involved than evaluating a single hormone.

Nearshore habitat use of Atlantic spotted and bottlenose dolphins off Bimini, The Bahamas

Kel Melillo-Sweeting¹, Christine A Ribic², Albert Beck², Kathleen Dudzinski¹
¹Dolphin Communication Project, Wallingford, Connecticut, ²U.S. Geological Survey, Madison, Wisconsin, ³Dolphin Communication Project, Port Saint Lucie, Florida

It is commonly assumed that sympatric species develop mechanisms to reduce areas of overlap to minimize competition, particularly when injury could result from agonistic interactions. Atlantic spotted (Stenella frontalis) and bottlenose dolphins (Tursiops truncatus) have been observed interacting in a variety of ways in nearshore coastal environments, but less is known about their space use patterns. We used sighting data (2003-2018) of Atlantic spotted (n = 253 sightings) and bottlenose dolphins (n = 204 sightings) to investigate how these two species spatially segregate along the nearshore coast of Bimini, The Bahamas. We looked at separation by geographic blocks (North, Central, South) and by ocean depth (<5m, 5-12m, 12-20m, 20+m bins). Because of a major disturbance (pier construction) in the Central block in 2014, we removed the 2014 data from analysis and, for each species, compared the
geographic and depth patterns before and after 2014. Each species followed a different geographic pattern that did not vary pre- and post-disturbance, with spotted dolphins using the North block more than other blocks and bottlenose dolphins using the South block more than other blocks. For depth, pre-2014, spotted dolphins used the 5-12m depth bin more than other depth bins in the North block, the 12-20m depth bin more in the Central block, but in the South block, did not use any specific depth bin preferentially. Post-2014, the only change to the pre-2014 spotted dolphin pattern was in the North block where spotted dolphins also used the 12-20 m depth bin more. In contrast, bottlenose dolphins used the 5-12 m depth bin more than the other depth bins in all blocks, regardless of pre-or post-2014. Our results suggest that while sympatric along the Bimini nearshore area, these two species segregate spatially by geography and ocean depth, which could reduce competition and resulting aggressive interactions.

**Determination of Total Body Length from Two Populations of Humpback Whale at Breeding Grounds in the South Hemisphere**

**Daniela Mello**¹, Milton Marcondes², Kátia R. Groch³, Cristina Castro⁴, Cláudio de Oliveira⁵

¹National Institute of Amazonian Research, Manaus, Amazonas, Brazil, ²Instituto Baleia Jubarte, Caravelas, Bahia, Brazil, ³Universidade de São Paulo, São Paulo, ⁴Pacific Whale Foundation, Ecuador, ⁵University of São Paulo - USP, São Paulo, São Paulo, Brazil

Body length (BL) determination from live migrating whales is important not only for behavioral and population investigations, but also to understand the ecological context of specific populations. Here, we combine two previously described techniques to determine the BL of 87 humpback whales (*Megaptera novaeangliae*) at two breeding areas: 79 individuals from the Southwest Atlantic (SA) (17°49'S, 38°49'W) and 6 from the Southeast Pacific (SP) (1°16'S, 81°04'W). Fluke images were taken between 2011–2013 with five Nikon cameras and two Nikkor 55-300mm and 80–400mm lenses together with distance determination using a rangefinder. Calibrations of camera-lens pairs were performed by taking photos of a 4 meters wide object from distances of 30, 60, 90, 120 and 150 meters: eight images were taken for each focal distance (ranging 70-400mm). In total, 736 images were used during calibration to generate regression formulas to determine the width of fluke (FW). The BL was then calculated using a previously described relation of FW to BL in humpback whales: \(BL = 0.77226 + 2.89694 \times FW\). All measured individuals also had the sex determined by molecular techniques. Mean BL of SA adult females (12.48m) was not different from SA adult males (13.01m) \((p=0.17)\). Comparison between SP sexes could not be performed given low number of sampled females. The 95% CI of BL from SA individuals empirically classified as juveniles the field \(n=3, 5.43-8.58m\) or calves \(n=2, 4.36-7.23m\) has not overlapped the CI calculated for adult individuals \(n=74, 10.37-15.15m\). Oppositely, SP whales classified as juveniles \(n=2, 7.68-11.37m\) overlapped the CI calculated for adults \(n=6, 7.65-12.49m\). SA adult males were bigger \(13.01m\) than SP adult males \(10.55m\) \((p=0.003)\). This may be a result of different food availability in the respective feeding areas, different degrees of stock depletion, among other ecological implications. The low number of sampled SP individuals should also be considered.

**Evidence for Year-Round Occupancy by Gray Whales (Eschrichtius robustus) on the Northern Sonoma and Southern Mendocino Coasts of California**

**Scott Mercer**¹, Theresa (Tree) Mercer², Shari Goforth-Eby²

¹Mendonoma Whale and Seal Study, ²Mendonoma Whale and Seal Study, cape neddick, Maine
Since January 2014, we have been conducting an annual census of migrating North Pacific gray whales (*Eschrichtius robustus*) as they travel from Northern feeding grounds to their breeding and calving grounds in the warm lagoons of Mexico’s Baja peninsula and their return migration to the Bering, Chukchi, and Beaufort Seas. In addition, we conduct daily surveys of all cetaceans observed and record their presence and behaviors. Our observation area along the northern California coast ranges from Jenner in Sonoma County north to Fort Bragg in Mendocino County with the majority of surveys taking place at the Point Arena Lighthouse peninsula. In 2016 we began noticing juvenile gray whales foraging in our study area. In the past two years we have begun photo documenting these juveniles as well as adult gray whales foraging in the area. When appropriate we have contributed photographs of individual grays to research groups such as Cascadia Research Collective in Washington and to Happywhale.com which uses photos to identify and track individual whales. We believe this represents an expansion of the Pacific Coast Feeding Group, a subset of the population known to feed through the summer and fall from Northern California to Southeast Alaska. We plan to collect and share further photo documentation of these grays whales to support our hypothesis.

The Decline in Numbers of Migratory Gray Whales (*Eschrichtius robust*) Counted from the Mendocino Coast of Northern California in 2020-2021 Compared to the Previous Two Seasons

Theresa (Tree) Mercer¹, Scott Mercer²
†Mendonoma Whale and Seal Study, cape negdick, Maine, ‡Mendonoma Whale and Seal Study

Since 2014 we have conducted a count of gray whales migrating south from northern feeding grounds primarily in the Arctic to breeding grounds in the lagoons of Baja Mexico and again as they return to their feeding grounds to the north. An Unusual Mortality Event first seen in January of 2019 has resulted in 430 known gray whale deaths as of 5 April 2021. The actual number of dead gray whales is likely significantly higher. As a result, the National Oceanic and Atmospheric Administration has reduced its estimate of 26,930 gray whales in 2016, to 20,580 in 2019/2020, a reduction of about 23.7%

We believe our numbers this season in comparison to the two previous counts show that decline. In 2018/2019 we counted 905 southbound grays and 783 northbound grays. In 2019/2020 we counted 735 southbound gray whales and 919 northbound grays. This season, 2020/2021 we recorded 702 southbound and 564 northbound as of 4 April 2021. That is a reduction of 203 less southbound than in 2018/2019, and thirty-three less 2019/2020. For our northbound count, we had 157 less than 2019 and as of 7 April 2021, 274 less than in 2020. The effort, the amount of days we observe, and the numbers of hours of observation each day has remained consistent each season. The amount of days we observe the gray whale migration each year is approximately 131. The number of hours of observation each day is an average of 4.5 hours.

Cetacean Detections vs. Soundscape Measurements: Is simpler better for passive acoustic monitoring?

Karlina Merkens¹, Simone Baumann-Pickering², Morgan Ziegenhorn³, Jennifer Trickey⁴, Ann Allen⁵, Erin Oleson⁶
¹NOAA/PIFSC, ²Scripps Institution of Oceanography, UCSD, La Jolla, California, ³Scripps Institution of Oceanography, UC San Diego, San Diego, California, ⁴Scripps Institution of Oceanography, San Diego, CA, ⁵NOAA Pacific Islands Fisheries Science Center,
Passive acoustics is an effective tool for monitoring the presence of vocal marine mammals in an underwater environment. Analysis of large datasets often requires automated methods, with the complexity of those methods varying from simple energy detectors to highly sophisticated AI systems. We compared the effectiveness of a simple frequency band measurement (‘soundscape metrics’) with more complicated detector/classifiers for monitoring mysticete, odontocete and anthropogenic sounds. We used a 12-year data set from deep-water (~900 m) off Hawai‘i in the North Pacific Ocean. The correlation between AI humpback whale detections and soundscape metrics (250 Hz octave levels) was moderate during the months when humpback presence was expected (rho ~ 0.3). There are multiple possible explanations for why this correlation is not higher, such as the granularity of the detector output or because although humpback calls are detected frequently when the animals are present, there are still many other sounds in the same frequency band at this location. The number of clicks identified by an odontocete click detector correlated well with the energy in a corresponding frequency band (31.5 kHz octave, rho ~ 0.5), indicating that simple soundscape metrics may be sufficient for monitoring the presence of clicking odontocetes over time. The anthropogenic signals were somewhat correlated with their respective soundscape metrics (echosounders pings: rho ~ 0.4, small vessels: rho ~ 0.2). Soundscape studies often rely on frequency band metrics, and here we demonstrate that for some signal types those measures may be a reliable indicator of the occurrence of specific signals. Such comparisons are highly dependant on the characteristics of the detectors and other automated tools used for analysis, such that care is required when choosing soundscape metrics for some monitoring locations and when comparing those outputs to other modes of examining the occurrence of various signal types.

Microplastics (MPs; plastics < 5mm) are highly bioavailable to marine organisms, including marine mammals, either through direct ingestion or indirectly by trophic transfer of plastic-contaminated prey. Demonstrated effects of ingested MPs include endocrine disruption and reduced feeding capacity, reproductive output, and energy reserves. Furthermore, they have been shown to translocate from the gastrointestinal tract to other organs, especially fatty tissues. Blubber is a lipid-rich, layered, and vascularized adipose tissue important for energy storage/mobilization unique to marine mammals. Known lipophilic and hydrophobic properties of MPs, along with their demonstrated ability to translocate via the circulatory system in other species, makes blubber a notable candidate sink destination for MPs ingested by marine mammals. However, studies examining translocation of MPs and subsequent metabolic effects have largely focused on readily cultured laboratory model (eg. zebrafish) or commercially important species even though marine mammals may be at a disproportionately higher risk of accumulating MPs in their bodies by virtue of their foraging behaviors and body morphology/composition. Here, we demonstrate the occurrence of putatively identified MPs < 180µm in blubber from both a common bottlenose dolphin (Tursiops truncatus; Nags Head, NC) and a gray whale (Eschrichtius robustus; Cordova, AK). Quantification and polymer identification using pyrolysis-GCMS are ongoing. While several studies have documented MPs in the gut of marine mammals, this is the first to identify translocation. Given that MPs have been shown to reduce energy reserves in other species, this finding suggests that energy
storage/mobilization may be negatively impacted in marine mammals. We plan to quantify the impact of MP presence in blubber by correlating MP concentration with differential expression of genes important in lipid catabolism, oxidation, synthesis and storage. Further research will document the occurrence of MPs in blubber for over 20 additional archived individuals (toothed & baleen whales, phocids) spanning sub-tropic to sub-arctic environments.

**Black and Blue Markets: Marine Mammal Conservation, Illegal Wildlife Trafficking, and the Challenge of Finding Legal Economic Alternatives**

Sarah Mesnick¹, Rebecca Lent², Vanda Felbab-Brown³, Lorenzo Rojas-Bracho⁴, Enrique Sanjurjo⁵, Valeria Towns⁶
1Southwest Fisheries Science Center, NOAA Fisheries, La Jolla, California, ²International Whaling Commission, United Kingdom, ³The Brookings Institution, Washington, DC, ⁴Ocean Wise, Ensenada, Baja California, Mexico, ⁵Pesca ABC, ⁶Museo de la Ballena, México, -, -, Mexico

Black markets for illegal wildlife products are a major driver of declining populations of endangered species and a persistent challenge to conservation. The demand for animals and their parts, or in some cases the incidental take associated with illegal harvest, results in diminishing populations and possible extinction. Worth tens of billions annually, illegal wildlife markets are often transnational, which adds to the complexity, and danger, particularly when organized crime and drug traffickers are involved. Due to global awareness campaigns, terrestrial examples are well known: elephant ivory, rhino horn, pangolin scales. Marine examples are far less well known but cause for concern: both vaquita (99% decline) and Caspian seals (90% decline) are bycatch in a fishery targeting an illegal product sold on an international black market (totoaba swim bladders and sturgeon caviar, respectively). This paper addresses this conservation challenge for marine mammals by exploring the profitability and other aspects of legal vs illegal trade - blue markets vs black markets. Market data for the Upper Gulf of California where vaquita live are reviewed and underscore the need for a wide array of approaches for ensuring that blue markets (~$20M USD) can effectively compete with black markets (~$50M USD). This relative profitability and other drivers of illegal vs legal economies are examined from a community point of view, considering not only distributional aspects of profits but also impacts on human and community well-being. This review highlights the importance of ensuring that policies do not undermine local livelihoods, particularly the ability to conduct legal activities, as enacted programs have had unintended consequences in the region. Illegal wildlife trade must be addressed in a manner that makes black markets less attractive than blue markets through demand reduction at the end market, targeted enforcement along the supply chain, and ensuring economic opportunities for communities.

**Breeding-site specific foraging habitat in southern elephant seals from Kerguenen Islands**

Julie Mestre¹, Hassen Allegue², Paul Lallement³, Yves Cherel¹, Samantha Patrick¹, Jean-Benoit Charrassin⁴, Christophe Guinet⁷
1CNRS, CEBC, LOCEAN, Sorbonne Université, Isques, France, France, ²Département des Sciences Biologiques, Université du Québec à Montréal, Montreal, ³Centre d’Etudes Biologiques de Chizé, VILLIERS EN BOIS, France, ⁴Centre d’Etudes Biologiques de Chizé (CEBC), UMR 7372 Université de la Rochelle-CNRS, Villiers-en-Bois, France, ⁵School of Environmental Sciences, University of Liverpool, Liverpool, United Kingdom, ⁶Sorbonne Université (UPMC, Univ. Paris 06) - CNRS-IRD-MNHN, LOCEAN-IPSL, Paris, France, France, ⁷Centre d’Études Biologiques de Chizé (CEBC),
Intraspecific niche specialization is a key factor to understand population dynamics in response to climate change and has strong implications for species conservation. However, it is rarely studied for distinct but spatially close breeding colonies of non-avian long-ranging marine predators. We investigated differences in the foraging habitat, behavior, and reproductive success in southern elephant seals (*Mirounga leonina*) breeding at two distinct sites on Kerguelen Islands—Rivière du Nord (RdN) and Pointe Morne, separated by approx. 75 km along the coastline. We analyzed post-breeding movements of adult female seals that were equipped with satellite-relayed data loggers, and stable isotopes collected on pups (a proxy for adult females) and on breeding males, reflecting the pre-breeding foraging trips. We also compared female reproductive success estimated from the body condition of their pups at weaning to detect any difference in fitness among both haul-out sites. During post-breeding (summer) foraging trips, females from Morne foraged mainly East of Kerguelen whereas females from RdN went West. They encountered contrasted environmental parameters, and females from RdN dived deeper and longer than those from Morne, suggesting different prey accessibility between both areas. During pre-breeding (winter) foraging trips, females and males from Morne foraged mostly in Antarctic waters, contrary to individuals from RdN that favored subantarctic waters. Moreover, females breeding at RdN were longer in size and weaned pups with a higher body condition compared to Morne. These results highlight for the first time segregation in foraging habitat, resulting in varying fitness, between two southern elephant seal colonies breeding on the same island. Such differences may have substantial consequences on the dynamics and resilience of the whole population in the face of a changing climate, and stress the necessity to stay cautious when generalizing some results from a few individuals to an entire population.

**Anthropogenic Noise Impairs Cooperation in Bottlenose Dolphins**

Pernille Meyer Sørensen¹, Abigail Haddock², Emily Guarino³, Kelly Jaakkola¹, Christina McMullen², Peter Tyack⁴, Stephanie King¹, Frants Havmand Jensen⁵

¹University of Bristol, Bristol, United Kingdom, ²Dolphin Research Center, ³Dolphin Research Center, Grassy Key, Florida, ⁴University of St Andrews, St Andrews, ⁵Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

A fundamental issue of societal importance is the impact of human disturbance on wildlife populations, with anthropogenic noise known to impact a range of taxa, including mammals, birds, fish, and invertebrates. This is particularly true for cetaceans, who rely on sound for vital tasks, with noise disturbance suggested to impair their ability to communicate or disrupt foraging. Previous studies have revealed how individuals may attempt to adapt to increasing noise levels (NL) through acoustic and behavioural compensation. Yet it remains unknown how noise impacts animals working together in groups. Here, we investigated the effect of noise on coordination between two bottlenose dolphins performing a cooperative task. We previously showed that the dolphin dyad can use whistles to coordinate their behaviour, working together with extreme precision. Each dolphin was equipped with a sound- and movement tag (DTAG3), while randomly exposed to one of four levels of increasing anthropogenic noise (1-20 kHz bandpass-filtered noise, received level: 130-165 dB re 1μPa, RMS) or a no noise control (mean ambient NL: 113 dB re 1μPa, RMS). Both dolphins nearly doubled their whistle durations and increased whistle amplitude (0.1-0.15 dB per 1 dB noise increase) in response to increasing NLs. Interestingly, these acoustic compensatory mechanisms are comparable to those used by...
wild cetaceans when exposed to anthropogenic noise. However, they proved insufficient in overcoming the effect of noise on behavioural coordination as cooperative task success dropped from 85% during no noise controls to 61% during the highest noise exposure (P = 0.01). To our knowledge, this is the first study in any species to demonstrate that noise impairs communication between conspecifics in a cooperative context. Cooperation facilitates vital functions across many taxa and our findings highlight the need to account for the impact of disturbance on functionally important group tasks in wild animal populations.

Eco-immunology and novel molecular tools for the assessment of the Australian sea lion (Neophoca cinerea) resilience to hookworm infection in a threatening and changing environment
Ignacia Meza¹, Rachael Gray², Damien Higgins³
¹The University of Sydney, Australia, ²The University of Sydney, Camperdown NSW, Australia, ³The University of Sydney, Sydney, NSW, Australia

As a top predator, the Australian sea lion (Neophoca cinerea) is a sentinel of ecosystem change, where population trends can reflect broader shifts in the marine environment. This endemic pinniped was historically diminished by commercial sealing, and recovery has been slowed by fishery interactions, disease and, potentially, pollutants. Hookworm infects 100% of neonatal pups and has been identified as a contributor to population decline. To understand how the immune system functions, protects wild hosts from disease or causes immunopathology, it is crucial to bring our immunological toolbox into wild populations to measure immune phenotypes in the context of disease and other potential sources of heterogeneity, such as age. Australian sea lion pups' immune profiles were assessed using serial blood samples collected from pups from two colonies located in South Australia (i.e. Seal Bay, high hookworm intensity season; and Dangerous Reef, low hookworm intensity season). RT-qPCR and novel digital-droplet PCR (ddPCR) assays were designed and validated to measure important immune mediators (cytokines) in Neophoca cinerea pups infected with hookworm. Results show different immunophenotypes between high and low hookworm infection intensity seasons, suggesting IL-6, IL-10 and TNFα as additional valuable parameters to assess N. cinerea pups health. Low expression of cytokines IL-4 and
IFNγ were identified by qPCR and confirmed with ddPCR. Novel approaches in pinniped immunology will help evaluate the impacts of environmental and anthropogenic factors such as pollutants, resource restrictions and other stressors on susceptibility to infectious diseases and help evaluate the impact of those diseases, thus guiding management decisions aimed toward protecting this declining species.

**Deep Voice - Utilizing Machine Learning to Understand “Whalish”**

*Michael Michelashvili¹, Michael Faran², Noa Weiss², Naom Bressler², Amit Galor², Tomer Nachshon²*

¹Tel Aviv University, Tel Aviv, Tel Aviv, Israel, ²Deep Voice, Tel Aviv University, Herzeliya, Israel

In 2018 we carried out a field session to record Humpback Whales from the C1 breeding group, in Bazaruto Archipelago, Mozambique. The initial research goals were recording the local dialect of whale song and attempting to catalog different types of social calls as well. The main obstacle we faced during the data analysis seems to be counterintuitive: huge amounts of recorded data!

Although large data sets have great potential to study the vocalizations, it requires a lot of time for preprocessing and tagging prior to the “real” analysis task.

To tackle this problem we turned to an emerging field that enjoys (although sometimes depends) on big amounts of data, Machine Learning. In recent years machine learning tools yielded state-of-the-art results in domains that were considered to be human-only capabilities: image classification, speech detection, text summarization, and many more examples are at hand.

We decided to found Deep Voice - a technological organization composed of biologists, physicists, programmers, and machine learning experts. Our goal is to create a process to utilize machine learning advancement and introduce many existing tools into the bioacoustic community. We believe in open source development, and encourage people from any field to use our tools, advise and join the creation process.

In the talk, we will survey the development of tools to tackle a core problem in the world of acoustic analysis: automatic classification and detection. We will share our future plans to incorporate those into population estimation and developing useful tagging tools for acoustic research.

We will present our open-source repository https://github.com/deep-voice/soundbay/, a deep-learning framework for bioacoustics that aims to reduce the overhead of applying deep learning algorithms for acoustical analysis.

**At-sea health check: validation of a system for on-board calculation and telemetry of lipid-store body condition of free-ranging marine mammals**

*Patrick Miller¹, Taiki Adachi², Philip Lovell¹, James Turnbull¹, Michael A. Fedak³, Baptiste Picard³, Christophe Guinet⁴, Erik Martin Biuw⁵, Theresa Keates⁶, Rachel Holser⁹, Daniel Costa¹⁰, Daniel Crocker¹¹*

¹Sea Mammal Research Unit, School of Biology, University of St Andrews, St Andrews, Fife, United Kingdom, ²Sea Mammal Research Unit, School of Biology, University of St Andrews, ³Scottish Oceans Institute, St. Andrews, Fife, United Kingdom, ⁴Sea Mammal Research Unit, St Andrews, Scotland, United Kingdom, ⁵Centre d’Etudes Biologiques de Chizé (CEBC), UMR 7372 Université de la Rochelle-CNRS, Villiers en Bois, France, ⁶Centre d‘Etudes Biologiques de Chizé (CEBC), Chize, France, ⁷Institute of Marine Research, ⁸University of California Santa Cruz, ⁹University of California, Santa Cruz, ¹⁰Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, ¹¹Sonoma State
Capital-breeding marine mammals rely on the ability to accumulate lipid energy reserves while on feeding grounds, in order to ensure survival and successful reproduction. Lipids, which have lower density than other tissues, decrease body density altering net buoyancy of divers. Archival tag data have shown that tissue body density can be derived via analysis of gliding performance during descent and ascent glides, made ubiquitously by marine mammals. To enable monitoring of changes in lipid stores (as an index of body condition) over entire feeding migrations, we encoded the hydrodynamic analysis algorithm onboard a Satellite Relay Data Logger (SRDL). Onboard analysis of 3-axis accelerometer data identified gliding periods made at steep (>50°) pitch angles during descent and ascent phases of dives. Speed and speed changes during glides >100m depth were used to calculate seal body density, telemetred via the ARGOS system. The data-processing algorithm has been validated with archival Dtag data of 8 southern elephant seals, with drift rate changes matching changes in body density calculated using the algorithm. We experimentally validated the algorithm by modifying the body density of three translocated seals by releasing weights while the seal was at sea. Two prototype SRDL tags successfully telemetered body condition changes of two northern elephant seals over their 8-month post-moult (pre-breeding) foraging migration. The on-board calculated body density values matched expected accumulation of lipid during foraging, confirmed by changes in drift rates of those tagged seals. Six version-2 prototype tags are currently functioning at sea during the post-breeding feeding migration. Next steps to account for diving air volumes will expand the applicability of the system to shallower-diving marine mammals. This approach is applicable to all marine mammal species, enabling direct study of at-sea body condition changes in relation to feeding effort, habitat, ecological factors, and anthropogenic disturbances.

**Examination of changes in reporting on and use of the Salish Sea by humpback whales**

**Hanna Miller**1, John Calambokidis2, Kiirsten Flynn3, Ryan Kelly4, Terrie Klinger4

1Ocean Associates, NOAA, Seattle, WA, 2Cascadia Research Collective, Olympia, Washington, 3Cascadia Research Collective, Olympia, Washington, 4University of Washington, School of Marine and Environmental Affairs, Seattle, Washington (WA)

Humpback whales (Megaptera novaeangliae) were extensively hunted in the North Pacific Ocean starting in the 1800s and were effectively removed from the inland waters of Washington state and southern British Columbia—collectively referred to as the Salish Sea—by the early 1900s. As the species has begun to recover worldwide, it is returning to historical habitats, including those in the Salish Sea. These waters are an important feeding ground for humpback whales, including the Central America and Mexico Distinct Population Segments, which are listed as endangered and threatened, respectively, under the Endangered Species Act in the U.S. While previous studies have examined humpback whale use of Washington outer coastal waters, only more limited research has been conducted in inland waters. We used a combination of opportunistic public sightings reports from three local non-profits and from a whale watch company, and scientific surveys conducted by Cascadia Research Collective to characterize the changes in humpback whale sightings in the Salish Sea from the 1980s to present. Efforts to remove duplicate sightings included screening of reports and grouping by date and location during analysis. The data show a sharp increase in the reporting of humpback whale sightings within the region starting in 2011. It also indicates an increased use of the region by humpback whales. Public sightings were most numerous near the San Juan islands and the eastern Strait of...
Juan de Fuca, while the scientific survey sightings show larger congregations in the western Strait of Juan de Fuca. These findings represent an important consideration for the management and protection of the species as more whales reliably return to the Salish Sea annually. Returning to their historical ranges has the potential to put the whales at risk with overlapping human uses of the region, including fishing efforts and vessel traffic throughout the Salish Sea.

Stable isotope profiles (δ13C, δ15N, δ18O, and δ34S) reconstructed from gray whale baleen provide insight into foraging behavior

McKayla Miller1, Emily Sperou2, Farzaneh Mansouri1, Jessie Huggins3, John Calambokidis4, Mandy Keogh5, Kate Savage6, Kerri J. Smith7, Stephen Trumble7, Sascha Usenko2

1Baylor University, Waco, TX, 2Baylor University, 3Cascadia Research Collective, Olympia, Washington, 4Cascadia Research Collective, Olympia, 5NOAA Alaska Region, Juneau, AK, 6NOAA Fisheries Juneau Protected Resources Office, Juneau, AK, 7Baylor University, Waco, Texas

North Pacific gray whales (Eschrichtius robustus) are highly migratory, spending the spring and summer months foraging in cold high-latitude waters then moving to warmer mid-latitude waters to calve and breed. Gray whales primarily rely on blubber stores generated during the foraging season to sustain them during the migration and while on the breeding grounds. However, a recent aerial photography study indicated that gray whales are arriving on the southern breeding grounds with decreased body condition compared to previous years, suggesting they failed to build adequate blubber reserves to sustain them throughout their migration. Baleen tissue was recovered from recent gray whale strandings (2019 and 2020, N=19) and provides time-series stable isotope data (1-3 years, 3-week resolution) used to retrospectively place individuals in time and space to illustrate migratory and foraging behavior. In this study, we investigated the utility of combining carbon (δ13C), nitrogen (δ15N), oxygen (δ18O), and sulfur (δ34S) isotope values from baleen tissue for an enhanced spatial dataset. Overall, δ13C and δ15N baleen profiles depicted seasonal foraging behavior, however, seasonal pattern inconsistencies between individuals emphasize variability in foraging behavior. In a preliminary assessment, δ18O values, known to correlate with sea surface temperature, were effective at placing animals latitudinally along their migratory route (enriched δ18O values indicate warm mid-latitude birthing grounds). Additionally, coastal δ34S values influenced by freshwater input were recorded in baleen tissue and can serve as a coastal proximity measure (enriched δ34S values in pelagic zones). We found that δ18O and δ34S contribute valuable spatial information to δ13C and δ15N datasets to elucidate individual foraging behavior. In future studies, this combined isotopic analysis will be utilized to assess the relationship between body store usage and feeding south of the foraging grounds to describe nutritional stress indicated by the documented decreased body condition of gray whales.

A Decision Support Tool for Assisting Multi-Interest Stakeholders in Assessing the Entanglement Risk of Large Whales in Commercial Fishing Gear

Burton Shank1, Alicia Miller1, Marisa Trego2, Alessandra Huamani1, Laura Solinger1, Mareike Duffing Romero1, André Price1, Sean Hayes3, Michael Asaro6

1NOAA Fisheries Northeast Fisheries Science Center, 2NOAA Fisheries, 3NOAA NEFSC, Biloxi, MS, 4NOAA Fisheries, Woods Hole, Massachusetts, 5NOAA NEFSC, EAST FALMOUTH, MA, 6NOAA Fisheries, Woods Hole, MA

The Atlantic Large Whale Take Reduction Team (TRT), formed in the United States under the
Marine Mammal Protection Act in 1996, recommends measures to reduce serious injuries and mortalities of North Atlantic right whales (Eubalaena glacialis), humpback whales (Megaptera novaeangliae), and fin whales (Balaenoptera physalus) due to entanglement in commercial fixed gear (trap/pot and gillnet) fisheries along the US east coast. We present a Decision Support Tool (DST) developed to assist the TRT in their decision-making process. The DST estimates the relative risk and severity of whale entanglement based on the spatial overlap of whales and fishing gear and the relative lethality of different gear types. The spatial distribution of large whales is primarily modeled based on habitat models developed by Roberts et al. (2016) while the spatial distribution of vertical lines from fixed gear fisheries utilizes a variety of state and federal fishery-dependent data sources. The relative lethality index, used to compare the differences in risk attributed to different fishing gear configurations, is derived from the discrepancy between observed and predicted gear configurations observed on severely-entangled whales. The tool can be configured and run quickly for simple scenarios, allowing stakeholders to rapidly evaluate various candidate management actions but is also capable of running multiple complex, interacting candidate actions. Originally developed for the case of the critically endangered North Atlantic right whale, we present the DST as an analytical model and stakeholder negotiation facilitator, discuss its present application, and explore pathways for future development and expansion.

Behavior-specific habitat association of common bottlenose dolphins (Tursiops truncatus) in Tampa Bay, Florida
Eliza Mills1, Shannon Gowans2, Elizabeth A. Forys3, Peter Simard4

1Texas A&M University- Corpus Christi, 2Eckerd College, St Petersburg, FL, 3Eckerd College, St. Petersburg, FL

Understanding how animals use their environment for different activities or behaviors is an important goal for ecological, conservation, and management applications. In this study free-ranging common bottlenose dolphins (Tursiops truncatus) were studied in Tampa Bay, FL between 2011 and 2018. During group follows, GPS (Global Positioning System) positions were collected every 30 seconds, and all behavioral states observed during the previous five minutes were recorded at five minute intervals. Group behavior was categorized into standard categories of foraging, milling, traveling, and socializing. For each dolphin group, a randomly chosen time and corresponding GPS position and behavior was selected for analysis. When multiple behaviors were observed during the five-minute period, the numerically rarest behavior was selected. If the group changed behavior during the follow, additional randomly selected times and corresponding positions were selected during the additional behaviors. To investigate if behaviors were associated with habitat features (seagrass beds, mangrove forests, artificial reefs, passes connecting the bay to open water, shoreline and nearest bathymetric line), distances between each point (and its corresponding behavior) and all habitat features were measured in ArcGIS Pro. All distances were measured around shoreline features, therefore representing routes dolphins might realistically navigate. This approach allowed us to investigate multiple habitat features simultaneously, rather than simply assigning a behavior to a single habitat type. Preliminarily analysis indicated that behavior changed significantly with distance from passes. By investigating associations between bottlenose dolphin behavior and different habitat features, we can better determine key locations for important behaviors such as socializing (including mating) and foraging. These behavior-specific habitat association results will not only increase our understanding of bottlenose dolphin behavioral ecology, but will allow for better management and conservation practices, such as
the establishment of combustion engine exclusion zones and minimum speed zones for boaters.

Protected Area Evaluation for the Conservation of Endangered Amazon River Dolphins (Inia geoffrensis)
Vanessa Mintzer¹, Vera da Silva², Anthony Martin³, Thomas Frazer⁴, Kai Lorenzen⁵
¹University of Florida, Arden, North Carolina, ²Instituto Nacional de Pesquisas da Amazônia - INPA, Manaus, Amazonas, AM, Brazil, ³Univ of Dundee, Cambs, ⁴College of Marine Science, University of South Florida, ⁵Gainesville, Florida

The potential value of protected areas for the conservation of cetaceans is widely recognized; however, few evaluation methods exist to assess their effectiveness. In this study, a modeling approach based on long-term mark-recapture/resight data was used to assess the effectiveness of a Brazilian reserve in protecting endangered Amazon River dolphins or boto (Inia geoffrensis), a species killed for use as fish bait. We built an annual discrete-time model with subdivisions based on hydrological periods and age classes. It included transition probabilities in and out of the reserve that were estimated utilizing multi-state mark-recapture models. To evaluate five reserve configurations, we re-estimated the transition probabilities to represent changes in the reserve boundaries. Model predictions showed that four scenarios, including one representing the existing boundaries, would be insufficient to protect the local boto population (n₀ = 528) and a steep decline in abundance would occur in the next 50 years (0 ≤ n₅₀ ≤ 108). However, one reserve configuration, encompassing both flooded forests and adjacent river habitats, and including beaches and channel/floodplain entrances, resulted in a nearly stable population in the same time frame (n₅₀ = 515). These findings suggest that, with careful design and efficient management, protected areas could be an effective conservation tool for boto populations that exhibit site fidelity to Amazonian floodplains. With appropriate mark-recapture/resight data, the modeling framework employed could be extended to evaluate and design protected areas for populations of other species in other systems.

Sea otter prey preference and abundance along the east coast of Hokkaido, northern Japan
Yoko Mitani¹, Satsuki Ochiai², Ippei Suzuki³, Randall Davis⁴
¹Kyoto University, Hokkaido, Japan, ²Hokkaido University, Hakodate, Hokkaido, Japan, ³Hokkaido University, Akkeshi-gun, Hokkaido, Japan, ⁴Texas A&M University, Galveston, Texas

Sea otters (Enhydra lutris) in Japan were hunted to near extinction during the maritime fur trade in the 19th and early 20th centuries before receiving protection in 1911. Periodic sea otter sightings along the east coast of Hokkaido in northern Japan have occurred during the past 20 years, and now they appear to have re-established in this area. The goal of this study was to identify: 1) sea otter foraging habitat, 2) prey preference, and 3) the abundance of sea urchins and bivalves near the islands along the eastern coast of Hokkaido. In 2020, we conducted a census of sea otters along the east coast of the Nemuro Peninsula and nearby islands from July-October. We observed a maximum of 23 sea otters, which fed predominately on bivalves (Clinocardium californiense, Callista brevisiphonata and others), sea urchins (Strongylocentrotus intermedius), crabs (Paralithodes brevipes and Telmessus cheiragonus), and chitons (Cryptochiton stelleri). The abundance of clams and sea urchins was estimated by sampling 0.25 m² quadrats at 22 sites (four replicates per site) on the sea floor (water depth: 3~12 m) on the western side of the island where sea otter congregate. The total area sampled was 22 m² with a mean sea urchin density of 6.9 m⁻² and a
mean bivalve density of 0.32 m². The mean energy content for sea urchins was 34.2 kJ, and the mean energy content for bivalves was 320 kJ. Hence, sea otters preferred larger bivalves, which had 9.3-fold more energy than sea urchins. It is likely that this small population will continue to expand in an area of commercially valuable invertebrates, so policies to mitigate conflict should be anticipated.

Kogia breviceps rescue and rehabilitation in Santa Catarina-Brazil
Cristiane Kiyomi Miyaji Kolesnikovas1, Marzia Antonelli2, Sandro Sandri2, Pedro Castilho3, Karina Groch4, Camila Morais5, Thaise Lima de Albernaz3, Emanuel Ferreira5
1Associação R3 Animal, Florianópolis, 2Associação R3 Animal, Florianópolis, SC, Brazil, 3Universidade do Estado de Santa Catarina, Laguna, Brazil, 4Instituto Australis - Right Whale Project, Imbituba, Brazil, 5Instituto Australis, Imbituba, Santa Catarina, Brazil, 6Projeto Baleia Franca / Instituto Australis, Imbituba, SC, Brazil, 7R3 Animal Association, São José, Santa Catarina, Brazil

On 19 October 2020 The Santos Basin Beach Monitoring Project (PMP-BS/ABIO 640/215) received at the Marine Animal Research and Rehabilitation Center/Associação R3 Animal (CEPRAM)-Florianópolis/SC/Brazil an individual of Kogia breviceps for rehabilitation. It was a female, 2.93m long, that had stranded in Imbituba/Santa Catarina/Brazil (-28.1663385, -48.6577602). Before rescue, the local community tried to refloat it three times without success. The animal was in good body condition, presented scars and wounds caused by cookie cutter shark and was severely dehydrated. The veterinarians decided to rehabilitate it, even knowing it would have minimal chance to survive. It was treated with diazepam and aminophylline, then transported in a customized trailer for cetaceans, while being constantly monitored. At arrival it was weighted (370 Kg) and samples for blood, biochemical and microbiological exams were collected. As recommend in literature and because of the hydration status of the animal, oral hydration with water and dextrose solution was started before any kind of food was offered. Once in the pool, as it could not float by itself, it was necessary to have people helping in the swimming pool 24h/day. Antibiotic therapy was started with enrofloxacin until antibiogram results. The next day, there were no changes in the animal behavior nor clinical condition, and the hydration/medication protocol was maintained. During the second night, the animal started to become more agitated and could swim and float by itself. Unfortunately, at 8:50 AM of 21 October it had apnea and bradycardia, and despite of veterinary efforts, it died. Necropsy and histopathological exams showed that the animal died because of stress. Even if the animal did not survive, the experience was important to learn more about species and help to have successful rehabilitation in the future.

Development of socio-sexual behavior in captive male bottlenose dolphin calves
Aoi Miyanishi1, Tomoko Mori2, Yuichiro Akune2, Keisuke Furuta3, Mai Sakai4
1Kindai University, Japan, 2Port of Nagoya Public Aquarium, Nagoya, Aichi, Japan, 3Suma Aqualife Park KOBE, Kobe, Hyougo, Japan, 4Kindai University, Nara, Japan

In this study, we describe the social interactions between male bottlenose dolphin calves and cohabiting females, the age at which they begin exhibiting sexual behavior. The aim of the present study was to clarify the development of sociality and socio-sexual behaviors in male calves, which can help during natural breeding in captive conditions. Male calf A, kept at the Port of Nagoya Public Aquarium, was observed for 39 days between 2 years and 1 month and 4 years and 1 month of age, while male calf B, kept at the Suma Aqualife Park KOBE, was observed for
29 days between 0 years and 11 months and 2 years and 4 months of age. We recorded solitary erection, socio-sexual behaviors including mounting, erection near a partner, contact with genital area, among other social behaviors during this period. At 1 year of age, we observed socio-sexual behavior toward mother (8.7 episodes/h) and mature females (0.5 episodes/h), and solitary erection or erection during suckling milk was observed (5.3 episodes/h). At 2 of age, socio-sexual behavior increased toward mothers (11.7 episodes/h). 3 years of age, socio-sexual behavior increased toward other mature females (2.4 episodes/h). Calf A and calf B exhibited socio-sexual behavior toward two of the seven females and two of the five females, respectively. These results indicate that calves increase their socio-sexual partners in the order of being solitary, being in presence of the mother, and other mature females, and that they prefer females. In the future, we will examine the relationship between female hormone levels and social behaviors including socio-sexual behavior of the male calves towards females to elucidate the factors that lead to specific female selection.

Pinger trials in Norwegian commercial fisheries confirm that pingers reduce harbour porpoise bycatch rates and demonstrate low level of pinger-associated negative impacts on day-to-day fishing operations

André Moan¹, Arne Bjørge²

¹Institute of Marine Research, University of Oslo, Moss, Østfold, Norway, ²Institute of Marine Research, Norway, Bekkestua, Akershus, Norway

A field trial was conducted to determine the effect of acoustic deterrent devices (ADDS, or pingers) on harbour porpoise (Phocoena phocoena) and harbour seal (Phoca vitulina) bycatch in three Norwegian commercial gillnet fisheries targeting cod (Gadus morhua), saithe (Pollachius virens) and monkfish (Lophius piscatorius). Catch data on 2,658 net-km-days were collected by 8 fishing vessels operating gillnets in high bycatch regions over two years. A total of 19 harbour porpoises and 9 harbour seals were bycaught, with all harbour porpoises and 67% of harbour seals taken in control (non-pingered) nets. Bycatch was modelled using a generalized linear mixed modelling approach and fitted with penalized maximum likelihood. Modelling results indicated that using pingers on gillnets reduced the risk of bycatching a harbour porpoise by an estimated 96.9% (95% CI 95% - 98%) compared to ordinary pinger-free nets. The effect of pingers was not significantly different between different fisheries. The pingers also had no significant effect on catch rates of fish (Wilcoxon rank sum test, p = 0.61) or harbour seals (Wilcoxon rank sum test, p = 0.25). Self-reported pinger-associated extra time costs on day-to-day fishing operations were low, averaging about 2.8 minutes per operation. These results add to a growing body of scientific evidence that pingers can lead to substantial reductions in harbour porpoise bycatch rates in gillnet fisheries, and that extra time costs associated with operating nets with pingers are low.

Results of 2019-20 Aerial Surveys of the Maui Nui Region, Hawaii: Are Hawaiian Humpback Whales on the Decline?

Joseph R. Mobley¹, Mark Deakos¹, Adam Pack², Guilherme Bortolotto³

¹University of Hawaii at Manoa, Honolulu, Hawaii, ²University of Hawaii at Hilo, Hilo, Hawaii, ³University of St Andrews, St Andrews, Fife, United Kingdom

Despite evidence of recovery that led to delisting from endangered status in 2016, recent data suggested that the Hawaii wintering population of humpback whales might be declining. Earlier aerial surveys (1993-2003) of the main Hawaiian Islands showed the population to be increasing 7% per year at that time, with highest densities in the Maui Nui (Maui, Molokai, Kahoolawe and Lanai) and Penguin Bank regions. Similar aerial
surveys of those regions were performed during the 2019 and 2020 winter seasons to derive comparable densities. A twin-engine Partenavia P68 aircraft flying at an altitude of 244 m (800 ft) and a speed of 100 knots was employed in 2019 and 2020. Tracklines consisted of north-south systematic lines spaced 26 km apart, extending 13 km past the 1000-fathom depth contour and with lines connecting endpoints. GPS, altitude, distance from the track line, group size and presence of calves were collected for each sighting. Survey crew consisted of a data recorder and one observer on each side of the aircraft. Surveys were conducted during the expected peak for whale densities (Feb-March). Data were analyzed using Distance (7.1). A total of 174 and 189 whales were sighted across 1,709 and 2,291 km of effort in 2019 and 2020 respectively. Comparison of densities with those observed in the Maui Nui region during the 1993-03 surveys revealed a slightly increasing linear trend, though non-significant (p = .09), across the 27-year period. The range of pods observed with calves increased from 5.2%-10.5%, for 1993-03, to 9.2%-10.6%, for 2019-20. The increases in density seen in 2019-20, when combined with those of other researchers are consistent with a "rebound" from the clear drop noted in previous years (2014-18). Taken together, these data do not suggest a wintering population on the decline, but one that is relatively stable and may actually be increasing.

**How the U.S. Endangered Species Act and Marine Mammal Protection Act Can Be Used to Protect Imperiled Marine Mammals and Promote Ropeless Fishing Gear**

**Kristen Monsell¹, Cari Sakashita²**

¹Center for Biological Diversity, Oakland, CA, ²Center for Biological Diversity

The U.S. Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA) are powerful conservation tools that seek to protect and recover imperiled marine mammal populations. We will provide a brief overview of how the ESA and MMPA work, and how these laws can be used to reduce the risk of entanglement in commercial fishing gear. We will provide a case study of increasing whale entanglements off the U.S. West Coast and how the use of the ESA resulted in a time area closure to protect whales during their migration, the adoption of a science-based risk assessment management program, and incentives to adopt ropeless (also known as “on-demand” or “pop-up buoy”) fishing gear. We will compare these efforts with efforts to use the ESA and MMPA to increase protections for North Atlantic right whales off the U.S. East Coast. We will describe how reported whale entanglements of the U.S. West Coast dramatically increased starting in 2014 and how from 2015–2020 over 280 whales were reported entangled. We will describe how litigation under the ESA lead to new regulations that have reduced (though not eliminated) the risk of entanglement. We will then describe how entanglements of North Atlantic right whales have increased, coinciding with a dramatic population decline, and continued despite litigation and other advocacy efforts under the ESA and MMPA. We will discuss possible reasons for the disparate outcome in the two cases. We will also describe efforts to require trap/pot fisheries to convert to ropeless fishing gear through the state legislative process.

**Identifying hotspots for human interactions with pinnipeds on New York beaches**

**Maxine Montello¹, Jill Pryor², Meghan Rickard³, Wendy McFarlane⁴**

¹New York Marine Rescue Center, ²New York Marine Rescue Center, Riverhead, New York, ³New York Natural Heritage Program; New York State Department of Environmental Conservation, Mount Sinai, NY, ⁴Manhattanville College, Purchase, New York
Long Island is among the most densely populated regions of New York state, accounting for approximately 40% of the population. Every year, seal species are observed hauled out on New York’s extensive beaches. These haul-out sites are often located in areas that experience high human usage, resulting in interactions between humans and pinnipeds – known as human interaction (HI) cases. In New York, HI cases include harassment, entanglement, vessel interaction, ingestion of pollution, illegal take, and handling. The New York Marine Rescue Center (NYMRC) has been responding to and rehabilitating stranded pinnipeds for over 25 years. Since its inception in 1980, NYMRC has responded to 3,485 marine mammal strandings with nearly 75% being pinnipeds. There are five species of seals known to inhabit New York waters; gray (H. grypus), harbor (P. vitulina), harp (P. groenlandicus), hooded (C. cristata) and ringed (P. hispida) seals. The objective of this study was to examine the last 10 years of live pinniped stranding in New York to quantify the frequency of HI cases and classify the interaction types. Over this time, NYMRC has responded to 408 live pinnipeds with 14% of those cases exhibiting HI. More than half of the HI cases have occurred in the last three years (2018-2020), with the highest frequency being documented during the 2020 (n=16) season. By analyzing stranding trends (over time and location), “hotspot” areas were identified. These locations of frequent HI will allow for focused rescue efforts, data collection and resource allocation to high need areas. Historical analysis is crucial to support pinniped populations utilizing habitat in the expanding New York greater metropolitan areas where human and pinniped beach use continues to overlap. Findings from this analysis support conservation initiatives for pinnipeds and allow for development of training procedures and outreach material targeted at areas of concern.

**Marine Environmental Stewardship in a Virtual World**

Amber Crittenden¹, Matt Montemurro², Kate Robb³

¹Marine Mammal Foundation, Melbourne, Victoria, Australia, ²Marine Mammal Foundation, Rosebud, Victoria, Australia, ³Marine Mammal Foundation, Mentone, Victoria, Australia

Education is key to empowering community and individual capacity to undertake effective conservation and sustainability initiatives within changing marine environments. As marine scientists, we have a unique ability and responsibility to educate communities to foster environmental connection, empower and inspire positive conservation action. The COVID-19 pandemic has presented many challenges for the delivery of and participation in community science engagement programs, with regular and ongoing initiatives being suspended or discontinued. In response, the Marine Mammal Foundation, Victoria, Australia, was able to adapt and adjust our in-person programs to enable ongoing participation opportunities in a time of unprecedented global crisis. Here we present examples of the successful transition of community engagement events, school-based marine science education programs, volunteering and citizen science opportunities, and youth engagement into online and widely accessible initiatives. This includes live webinars and presentations, the development and initial distribution of a flagship online education course for schools and community groups, live online school incursions, live online youth engagement programs, and uploaded pre-recorded content. Across 45 online activities, we have been able to engage over 1000 participants from across Australia, fostering ongoing environmental stewardship throughout this time. Outcomes include raising awareness of local marine environments; highlighting impacts and mitigation of anthropogenic threats; encouraging ongoing youth participation in applied science;
and empowering individual and community conservation and sustainability action. Through dedicated and innovative community engagement, we are able to ensure continued environmental stewardship through the COVID-19 pandemic and into the future.

Curtailing Whale Entanglements by Advancing On-Demand Fishing Gear
Michael J Moore¹, Erica Fuller², Regina Asmutis-Silvia³, Henry Milliken⁴, Eric Matzen⁴, Patrick Ramage⁴, Mark Baumgartner⁵, Brian Sharp⁶

¹Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, ²Conservation Law Foundation, ³Whale and Dolphin Conservation, Plymouth, MA, ⁴NOAA Fisheries NEFSC, Woods Hole, Massachusetts, ⁵Biology department, Woods Hole Oceanographic Institute, Woods Hole, MA, ⁶International Fund for Animal Welfare (IFAW), Yarmouthport, Massachusetts

Entanglement risk can be substantially reduced by retrieving bottom stowed gear without the use of static vertical lines, where acoustic on-demand systems mark and retrieve traps in their place. We trialed four on-demand systems under normal fishing conditions in the US commercial lobster fishery. Twenty-three vessels have used the gear: offshore (2020 - 3, 2021 - 7) and inshore, (2020 - 4, 2021 - 9). Here we report offshore data: with between 9 and 290 hauls per vessel. Most trawls were hybrid with an acoustic release at one end of the trawl and a traditional endline at the other end. On-demand trawls were recovered 351 times. Three different brands were used under variable conditions including: 73 - 219 m depth; 0.5 to 2.2 knots of current; and 1 – 4 m swells. No unintended releases were documented during fishing trials. Successful acoustic retrieval occurred 67% of the time in 2020, and 87% in 2021. Failures in recovery were documented and mainly involved line snarls. Improved latch mechanisms reduced this issue. Other gear enhancements that resulted from industry input included improved visibility of surfacing gear, through hull transducers, and acoustic range. Only 8/351 (2.3%) instances of gear movement were reported, involving storms or being dragged by mobile gear. Participants indicated that gear movement was substantially lower than traditional gear under similar circumstances. With appropriate permitting, fishing in 2022-2023 will include the ability to fish without static endlines in Restricted Areas otherwise closed. While this trial was not designed to address affordability, we acknowledge that the gear costs must be reasonable and parallel efforts by NGO partners are addressing this issue. Reducing gear conflicts between both mobile and fixed gear fishermen is an issue we plan to address. This is critical to advancing on-demand gear in the future. Challenges include expeditious permitting.

Balancing urgent action with long-term gains: Canada’s approach to support Southern Resident Killer Whale recovery
Kendra Moore, Vancouver

The recovery and survival of an endangered population, such as the Southern Resident Killer Whale, is complex due to the cumulative impact of human activities within the marine environment that threaten the species. It is within this challenging environment that the Government of Canada has implemented a management regime to address the primary threats to the recovery of the population, including reduced prey availability (primarily Chinook salmon), physical and acoustic disturbance, and contaminants. Due to the continued decline of Southern Resident Killer Whales, the Government of Canada has worked with Indigenous groups, scientific and technical experts, and stakeholders to put in place an interim approach informed by the best available information, while concurrently developing and researching longer-term solutions. This approach enables the Government of Canada to utilize
more nimble regulatory and voluntary solutions to take action quickly, while alongside, a longer-term approach is explored based not only on lessons learned from the interim approach, but also expanded to consider broader actions and benefits to other species and processes. For example, to address the threat of reduced prey availability, the interim measures include salmon fishing closures within Southern Resident Killer Whale key foraging areas. Longer-term actions being explored focus on salmon habitat restoration and protection, salmon enhancement, predation and forage fish, which will not only benefit Southern Resident Killer Whales, but also at-risk salmon populations. The Southern Resident Killer Whale management measure process can be reviewed as a case study for the implementation of ecosystem-based and integrated management principles: using the ecosystem level context, despite a singular species focus.

Is resonance involved in the amplification of Weddell seal (Leptonychotes weddelli) vocalizations?

Jennifer Moore¹, John M. Terhune¹, Kimberley Davies¹
¹University of New Brunswick, Saint John, New Brunswick

Weddell seals (Leptonychotes weddellii) produce very high amplitude underwater vocalizations. The mechanism used to amplify these vocalizations is unknown. The source-filter theory suggests that resonance within air-filled chambers of the vocal tract may be involved in this amplification. Resonant amplification can only occur at specific frequencies whose wavelengths are directly proportional to the size of the resonating chamber. This study examined the patterns of amplification within tonal trills (20 – 0.1 kHz down sweeps, n = 92 from a single seal and n = 80 from other seals) produced by male Weddell seals for evidence of consistently amplified frequencies across three analysis methods. Average power spectrums were inspected for local amplitude maxima. Distributions of frequencies of absolute maximum amplitude (MA) per trill were tested against random distributions to look for frequencies where MAs occur more often than they would by chance. This was done using goodness of fit tests and cluster analysis. Different methods located different amplified frequencies but amplification at ~2.7 kHz was consistent across all three methods. All methods showed deviance from the distributions that would be expected in the absence of resonance. Based on the agreement between methods, evidence that resonance occurs in Weddell seal sound production, but knowledge of Weddell seal vocal anatomy is insufficient to draw conclusions about which structures in the vocal tract may be acting as resonance chambers. The evidence of resonance in Weddell seal vocalizations provides insight into which components of the vocal characteristics are controllable by the seal, and which are only a product of the size of the vocal tract.

Access to High-Quality Archived Marine Mammal Samples; is it possible?

Amanda Moors¹, Jennifer Ness¹, Debra Ellisor¹, Jennifer Hoguet¹, Rebecca Pugh¹, John Kucklick¹, Randall Wells¹, Wayne McFee⁴, Wendy Noke-Durden³, Barbara Mahoney⁴, Anna Bryan⁷, Lori Quakenbush⁶, Robert Suydam⁸, Raphaela STIMMELMAYR¹⁰, Kathleen Burek-Huntington¹¹, Pamela Lestenkoff¹², Teresa Rowles¹³
¹National Institute of Standards and Technology, Charleston, SC, ²NIST-Chemical Sciences Division, Hollings Marine Laboratory, Charleston, SC, ³Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, Florida, ⁴NOAA, Charleston, South Carolina, ⁵Hubbs-Sea World Research Institute, Melbourne Beach, FL, ⁶Alaska Regional Office, NMFS, NOAA, Anchorage, AK, ⁷Alaska Department of Fish and Game, ⁸Alaska Dept. Fish and Game,
Access to high-quality biospecimens and associated data which have been archived in a standardized manner over decades can be challenging. The National Institute of Standards and Technology (NIST), which began archiving specimens for contaminant trend monitoring in 1979 through multiple collaborations, has provided access to high-quality frozen biospecimens through formal tissue access policies. Current projects focusing on the archival of marine mammal samples include the Marine Mammal Health and Stranding Response Program and the Alaska Marine Mammal Tissue Archival Project, both of which are part of the National Oceanic and Atmospheric Administration’s (NOAA) National Marine Mammal Tissue Bank (NMMTB), and are maintained by NIST at the NIST Biorepository. The NMMTB was developed in 1989 and codified by Federal legislation in 1992 (PL 102-587) as part of the Marine Mammal Health and Stranding Response Act in response to a common bottlenose dolphin (T.truncatus) mortality event where a lack of banked specimens left questions unanswered concerning baseline levels and trends of environmental contaminants. Additionally, in 2002 NIST began collaborating with NOAA and the Chicago Zoological Society to assess the health of bottlenose dolphins. These studies involve the safe catch-and-release of animals in the wild during which health measurements and samples are collected and analyzed following standardized protocols, facilitating comparisons. The NMMTB provides a resource of biospecimens from over 40 species of marine mammals collected in a systematic and well-documented manner for evaluation of temporal trends for future retrospective analyses, new analytes of interest, and improved analytical techniques. Collections of these samples would not have been possible without the diligent work of partners in the national marine mammal stranding network, research organizations, and collaborations with tribal organizations and hunters in Alaska. Through tissue access policies, the scientific community may request samples from the NMMTB and the marine mammal health assessments for scientific research.

Short-term effect of boat noise on the acoustic behaviour of the short-finned pilot whale (Globicephala macrorhynchus) in southern Tenerife, Spain

Misael Morales Vargas¹, Kayla-May Summers²

¹Biosean Whale Watching and Marine Science, Las Chafiras, Santa Cruz de Tenerife, Spain,
²University of Roehampton, London, United Kingdom

The negative effect that pollution has on the ecosystems is well known. Anthropogenic noise is one of the most disruptive pollutants causing behavioural changes to species. Short-finned pilot whales (Globicephala macrorhynchus) are deep-diving odontocetes that highly rely on their acoustic. While the anthropogenic noise and behaviour changes have been studied, the effect of human noise on the acoustic behaviour of G. macrorhynchus has not been deeply explored. This study took place in Southern Tenerife, Spain, where 17 field surveys were performed between August and September 2019. The goal was to investigate the short-term effect of boat noise on the acoustic behaviour of the species. During the surveys, the number of boats present in the area was annotated and, with a hydrophone, audio files containing pilot whale calls and boat noise were recorded. Spectrograms were analysed to find the fundamental frequency (Hz). The difference between the mean number of whale calls with no other boat present and
multiple boats present was estimated. A Spearman’s rank was performed to test the correlation between the number of boats and the number of calls. The results show that there was an overlap in the fundamental frequency of the whales and the boat noise; there was no difference between the number of calls when only one boat or multiple boats were present. However, as the number of boats increased, calls decreased. These results imply that the communication of the species can be disrupted. While it is unclear what the long-term implications that anthropogenic noise can have on *G. macrorhynchus*, this study suggests that it could lead to a possible decline of the species due to stress. With this idea, the effect of anthropogenic noise on marine species needs to be studied more, to ensure that ecosystems and species are not negatively affected by human activities.

### The Decline of Humpback Whales in Prince William Sound, Alaska Following the 2014–2016 Northeast Pacific Marine Heatwave

**John Moran**¹, Jan Straley², Olga von Ziegesar³

¹NOAA Fisheries/Alaska Fisheries Science Center, Juneau, AK, ²University of Alaska, Sitka, Alaska, United States Minor Outlying Islands, ³Eye of the Whale, Fritz Creek, AK

Humpback whale (*Megaptera novaeangliae*) numbers have failed to recover in Prince William Sound (PWS), Alaska following a steep decline during the 2014-2016 northeast Pacific marine heatwave (PMH). Humpback whales in PWS feed primarily on Pacific herring (*Clupea pallasii*), especially when herring aggregate in large shoals during the spring, fall, and winter. Typically, humpback whale numbers and distribution within PWS correlate to herring spawning biomass, both herring and whales declined following the PMH. However, in 2020 and 2021 there was some recovery in the herring population, but no corresponding increase in humpback whale numbers. Prior to the PMH, counts of whales averaged 74.0 ± 44.8 SD and 101.6 ± 43.3 SD in the spring and fall, respectively. In the years following the PMH, counts dropped to an average of 9.3 ± 2.4 SD and 19.5 ± 9.1 SD in the spring and fall, respectively. It is possible that a change in herring behavior or a reduction in the caloric value of prey has made PWS a less profitable location for whales to forage forcing them to new feeding grounds. Alternatively, they may not have survived the prey shortages associated with the PMH. Determining the fate of the missing PWS whales and the mechanisms behind their decline is critical to understand how this population responds to future predicted marine heatwaves in the Gulf of Alaska associated with global climate change.

### Apical Morphology of the Inner Ear in Odontocetes: Using the Pairing Hair Cell - Deiters Cell as a Marker to Detect Lesions

**Maria Morell**¹, Lonneke IJsseldijk², Marina Piscitelli-Doshkov³, Sonja Ostertag⁴, Vanessa Estrade⁵, Martin Haulena⁶, Paul Doshkov⁷, Jérôme Bourien⁸, Stephen Raverty⁹, Ursula Siebert⁰, Jean-Luc Puel¹, Robert Shadwick¹¹

¹Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Büsum, Germany, ²Faculty of Veterinary Medicine, Utrecht University, Utrecht, Netherlands, ³University of British Columbia - Vancouver, Kill Devil Hills, NC, ⁴University of Waterloo, Waterloo, ON, ⁵GLOBICE-REUNION, Saint Pierre, Reunion, ⁶Vancouver Aquarium, Vancouver, BC, ⁷National Park Service, Nags Head, NC, ⁸Institute for Neurosciences of Montpellier (Inserm Unit 1051), Montpellier, France, ⁹The Animal Health Center, Abbotsford, British Columbia, ¹⁰Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Büsum, Schleswig-Holstein, Germany, ¹¹University of British Columbia, Vancouver
The apex or apical region of the cochlear spiral within the inner ear encodes for low-frequency sounds. The disposition of sensory hair cells on the organ of Corti (or hearing organ) is largely variable in the apical region of mammals, and it does not necessarily follow the typical three-row pattern of outer hair cells (OHCs). As most underwater noise sources contain low-frequency components, we expect to find the most lesions in the apical region of the cochlea of odontocetes, in those cases that have permanent noise-induced hearing loss. To further understand how man-made noise might affect cetacean hearing, there is a need to describe normal morphological features of the apex and document interspecific anatomic variations in cetaceans. However, distinguishing between apical normal variability and hair cell death is challenging. Here, we describe anatomical features of the organ of Corti of the apex in 23 ears from five species of odontocetes (harbor porpoise Phocoena phocoena, spinner dolphin Stenella longirostris, pantropical spotted dolphin Stenella attenuata, pygmy sperm whale Kogia breviceps and beluga whale Delphinapterus leucas) by scanning electron microscopy and immunofluorescence. Our results showed an initial region where the lowest frequencies are encoded with two or three rows of OHCs, followed by the typical configuration of three rows of OHCs and three rows of supporting Deiters cells. Whenever two rows of OHCs were detected, there were usually only two corresponding rows of supporting Deiters cells, suggesting that the number of rows of Deiters cells is a good indicator to distinguish between normal and pathological features.

The Cetacean Genomes Project: Genomic infrastructure for studies of cetacean evolution, diversity, and conservation

Phillip Morin (he/him)¹, Michael McGowen², Andrew Foote¹, Jacquelyn Mountcastle³, Jennifer Balacco⁴, Olivier Fedrigo⁵, Erich Jarvis², Marlys Houck⁴, Oliver Ryder⁶, Matthew Schmitz⁷, Teresa Rowles⁸, Rebecca Pugh⁹

¹Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, La Jolla, CA, ²Smithsonian National Museum of Natural History, ³Department of Natural History, University Museum, Norwegian University of Science and Technology, Trondheim, Norway, ⁴Vertebrate Genome Lab, The Rockefeller University, New York, NY, ⁵Laboratory of Neurogenetics of Language, The Rockefeller University, New York, ny, ⁶San Diego Zoo Wildlife Alliance, Beckman Center for Conservation Research, Escondido, CA, ⁷University of California, San Francisco, San Francisco, CA, ⁸Silver Spring, Maryland, ⁹NIST-Chemical Sciences Division, Hollings Marine Laboratory, Charleston, SC

Reference-quality genome assemblies provide species representation of nearly complete and contiguous, chromosome-length, gene-annotated genomic data. Such assemblies are the platinum-standard for comparative and population genomic analyses in evolutionary, biodiversity and conservation-focused studies. The Cetacean Genomes Project (CGP) was established in early 2020 as a broad collaboration in coordination with the Vertebrate Genomes Project (VGP), to support sample collection, obtain funding, and coordinate reference genome assemblies for all 90 cetacean species. At the time the CGP began, there were only two cetacean species with reference-quality genome assemblies, comprising the smallest and the largest of the Cetacea (vaquita and blue whale). By the end of 2021, we expect completion of at least 10 cetacean reference genomes, including species from at least nine of the 14 cetacean families (Delphinidae, Phocoenidae, Monodontidae, Iniidae, Ziphiidae, Kogiidae, Balaenopteridae, Eschrichtiidae, Balaenidae), spanning the breadth of the phylogenetic tree. These reference genomes provide the genomic infrastructure to enable cross-species genomic assembly of most other cetacean species to a family-level reference sequence, rapidly advancing genomic
applications, including transcriptomics, proteomics, toxicogenetics, and functional genomics across the Cetacea. Analyses of genomic diversity, historical demography, gene composition and genomic evolution from these reference sequences reveal diverse and complex evolutionary histories. Genome-wide diversity ranges over more than an order of magnitude, reflecting differing impacts of intrinsic and extrinsic factors, including oceanographic and climatic changes of the Pleistocene. In the coming years, we will continue to add species as funding permits, with the ultimate goal of sequencing every cetacean species to a platinum-standard.

Right whales, ropeless fishing and coexistence in the Gulf of St. Lawrence: the inspiring story of Canadian fisheries.
Lyne Morissette¹, Philippe Cormier², Jean Côté³, Dounia Daoud⁴, Martin Noël⁵
¹M - Expertise Marine, Sainte-Luce, Québec,
²CORBO inc., Caraquet, New Brunswick,
³Regroupement des pêcheurs professionnels du sud de la Gaspésie (RPPSG), Chandler, Quebec,
⁴Homarus inc., Shediac, New Brunswick,
⁵Association des Pêcheurs Professionnels Crabiers Acadiens (APPCA), Shippagan, New Brunswick

The presence of North Atlantic Right Whales is increasing in the Gulf of St. Lawrence, eastern Canada, since 2015. Occupying this new territory led to new interactions with other users of the marine environment, and thus new conservation challenges. In order to reduce the risk of entanglement, crab and lobster fishermen from a dozen of organizations in Eastern Canada developed, in partnership with scientists, engineers, NGOs and governments, different approaches to adapt their operations and fishing gear to the presence of NARW on fishing grounds and to co-exist in the Gulf. This level of commitment for whale conservation and collaboration between different associations is unprecedented. The efforts and involvement of fishermen helping whales focus on three main aspects: 1) an inclusive management/mitigation system, where they are involved in early stages of the process, to reduce spatial-temporal overlap between whales and fisheries in the Gulf of St. Lawrence; 2) the development of new technologies of fishing gear to reduce entanglements when fishermen and whales are overlapping in space and time; and 3) involvement in scientific research on NARW and whale rescue in the Gulf. Since 2020, two crabbers associations (ACA and APPCA) are even fishing under an experimental fishing licence that allowed snow crab professional fishers to access fishing areas that were otherwise closed. Each fisher was allowed additional experimental ropeless traps to prosecute this “real life” experimental fishery. Real progress is being achieved here thanks to the successful interaction between fishers and the engineers/scientists that are involved in this project. A variety of other initiatives and advances are developed for coastal and offshore fisheries, by Canadian fishermen are great examples of how we can work together to find efficient conservation solutions for the North Atlantic Right Whale, at a time where concertation and co-existence are the key to make a significant difference.

Come together: Whistling concert of rough-toothed dolphins (Steno bredanensis) in the Southwestern Atlantic Ocean
Juliana Moron¹, Daiane Anzolin², Leonardo Versiani², João P.M.MURA³, Thiago Amorim³, Gabriela Colombini Corrêa³, Artur Andriolo⁶, Renata Sousa-Lima⁷
¹Ocean Whispers, Sorocaba, São Paulo, Brazil,
²Ocean Whispers, Toveri Gerenciamento de Projetos Integrados, Florianopolis, Santa Catarina, Brazil, ³Ocean Whispers, Arraial do Cabo, Brazil, ⁴Universidade Federal de Juiz de Fora, Juiz de Fora, Minas Gerais, Brazil, ⁵Projeto Cetáceos da Costa Branca, Natal, Rio
The rough-toothed dolphin (*Steno bredanensis*) whistle parameters had not been thoroughly investigated in Brazil. This work aims to provide not only an overview of the species' whistling patterns in Brazil with data collected in different locations with different populations, but also explore how whistling activity varies in different scenarios. Acoustic data was collected during a) seismic activity in 2020 in Campos Basin (130min), b) two research cruises in 2014 (165 min) and 2015 (120 min) over the Brazilian continental shelf break and slope (Talude), and c) sailboat cruises dedicated to the study of the humpback whale (*Megaptera novaeangliae*) in the Abrolhos Bank area in 2004 (240min). All recordings were done using omnidirectional hydrophones with 1-4 elements, with different sample rates (48kHz, 96kHz and 500kHz) and systems (SONY PCM-M1, AUSET and SEICHE). The whistles were manually analyzed with the software Raven Pro 1.6 (SNR >=10db). We analyzed 752 whistles that presented diversified preferences of contours for each recorded situation. Constant, upsweep and downsweep were the most emitted contours. The highest values of start and minimum frequencies were obtained in the seismic recording. The Talude recordings presented more variation in the whistles, such as delta, center, peak, maximum and final frequency and number of steps. On the other hand, the Abrolhos recordings presented the lowest variations for all parameters. The results obtained suggest whistle patterns might be explained by individual, geographic and/or behavioral variation. This work is part of a proposal for an acoustic description of the species in Brazil, and an important step for further opportunistic and collaborative research in the South Atlantic Ocean.

**Evaluating Adherence with Voluntary Slow Speed Initiatives to Protect Endangered Whales**

Jessica Morten¹, Sean Hastings², Ryan Freedman²

¹NOAA's Channel Islands, Cordell Bank, and Greater Farallones National Marine Sanctuaries, Greater Farallones Association, San Francisco, CA. ²Channel Islands National Marine Sanctuary, Santa Barbara

Vessel strikes are one of the main threats to large whales globally and to endangered blue, fin, and humpback whales in California waters. For over 10 years, NOAA has established seasonal voluntary Vessel Speed Reduction (VSR) zones off of California and requested that all vessels ≥ 300 gross tons (GT) or larger decrease speeds to 10 knots or less to reduce the risk of vessel strikes on endangered whales. We conducted a comprehensive analysis quantifying cooperation levels of all vessels ≥ 300 GT from 2010 to 2019 within designated VSR zones using Automatic Identification Systems (AIS) data. While average speeds of large vessels have decreased across the years studied, cooperation with voluntary 10-knot speed reduction requests has been lower than estimated to be needed to reduce vessel-strike related mortality to levels that do not inhibit reaching and maintaining optimal sustainable populations. A comparison of vessel speeds across inactive and active voluntary VSR time periods show a modest (+15%) increase in cooperation from 2017-2019. A complementary, incentive-based VSR program that was started in 2014 and scaled up in 2018 within the region likely improved voluntary VSR cooperation levels, as participating container and car carrier vessels travelled at lower speeds during the VSR season than vessels not enrolled in the incentive-based effort. Comparisons of vessel speeds in the incentive-based VSR program across inactive and active time periods showed a significant
(+41%) increase in cooperation. With cooperation levels for the voluntary VSR hovering around 50%, and the challenge of funding and sustaining an incentive-based VSR program, voluntary VSR approaches may be insufficient to achieve cooperation levels needed to significantly reduce the risk of vessel strike-related mortality for these federally protected whales, suggesting that VSR regulations warrant consideration.

A dynamic bioenergetic agent-based model to assess population level cumulative noise impacts on harbour seals
Lars O. Mortensen¹, Frank Thomsen²
¹DHI, Hørsholm, Denmark, ²DHI, Hørsholm, Denmark

Large-scale exploration of the sea is undertaken in multiple parts of the world, with activities often overlapping in both time and space. This can lead to cumulative impacts on ecosystem components such as marine mammals. One of the key questions when studying cumulative impacts of human activities on marine mammals is how behavioural changes in response to anthropogenic stressors translate into population impact. Central place foragers (CPF), such as many pinnipeds often venture far on feeding bouts, visiting areas of known good feeding areas. However, these foraging excursions represent a bioenergetic investment with the expectation of higher bioenergetic reward for the effort. Feeding bouts can be interrupted by high intensity noise from anthropogenic activities, for example offshore wind farm construction. While pinnipeds can reduce the immediate impact of noise by moving away from the source or hauling-out for the duration of the impact, frequent interruptions will likely have detrimental bioenergetic consequences for the individual with possible knock-on effects on the population. However, the potential population impacts of noise disturbances on pinnipeds are not well understood as there is limited knowledge about the bioenergetic consequences of behavioural changes. Here, we present a bioenergetic agent-based model (ABM) for harbour seals (Phoca vitulina) in the North Sea. In the ABM, behavioural decisions are governed by the bioenergetic state of the agents. Using pattern-oriented modelling, the model was validated using accessible behavioural and bioenergetic data from peer reviewed literature or public sources. Results showed that the harbour seal ABM was able to reproduce key elements of the bioenergetic annual cycle of the species in the North Sea, along with realistic daily activities. The aim of the model is to develop a tool for managers to assess cumulative populations impacts on central place foragers such as the harbour seal to aid marine spatial planning.

Procustean analysis for spatial comparison of densities in common coastal bottlenose dolphins (Tursiops truncatus) vs. artisanal fisheries in the southwestern Gulf of Mexico
Eduardo Morteo¹, Domenico La Fauci², Nina Medellín³, Israel Huesca-Domínguez⁴, Christian Delfín-Alfonso⁴, Luis Abarca-Arenas¹
¹Instituto de Investigaciones Biológicas, Universidad Veracruzana, Xalapa, Veracruz, Mexico, ²Facoltà di Agraria e Scienze, Università Politecnica delle Marche, Polo Monte Dago, Ancona, Italy, ³Marine Mammal Laboratory (LabMMar, IIB-ICIMAP) Instituto de Investigaciones Biológicas- Instituto de Ciencias Marinas y Pesquerías, Universidad Veracruzana, Boca del Río, Veracruz, Mexico

Distribution patterns for wildlife are often hard to find at sea due to its dynamic nature over different – time and space – scales. Large amounts of data over extended periods might be necessary to accurately estimate population densities, and comparisons among different targets usually lack statistical analyses to assess similarities in their distributions. We used 42 photo-id transect surveys conducted during three years within a 120 km² open and highly
productive shallow area in front of the Alvarado lagoon system, to acquire in situ geographic positions of several study targets. First, we used dolphin schools including: A) only adults (n=52), B) adults and young (n=31), C) adults and calves (n=16), and D) adults, young and calves (n=47); we also used records of known sexed individual dolphins (F=40, M=17), and established the location of fishing boats (n=980) and gear (n=320). Target counts were transformed to density contours (inverse distance weighted Kernels) pooling all geographic positions of each target type across the study period using QGis 3.18. Density values were extracted from raster images resulting in eight density matrices with 120 cells (1 km²) each. Concordance among these matrices was tested using ProTest in the vegan R package, providing a measure of the overall fit (m₁₂) and its significance (p) under 9,999 permutations. Most pairwise comparisons (71%) were highly (m₁₂>0.66) and significantly (p<0.01) concordant, showing similar shapes, but overlapping density distributions as well; this was expected due to the widespread influence of the lagoon which attracts both dolphins and fishers. However, 86% of the discordances (i.e. 25% of all pairwise comparisons) corresponded to nursing schools, especially towards fishing vessels. Dolphin-human reciprocal avoidance is known in the area, but this approach proved useful in detecting specificity for nursing groups which are particularly vulnerable to marine traffic, having potentially long-term negative consequences in population viability.

**Ecological predictors of home range size of the endangered Amazon river dolphins (Inia geoffrensis) in the Amazon and Orinoco basins.**

Federico Mosquera Guerra¹, Fernando Trujillo², Jairo Pérez Torres¹, Hugo Mantilla-Meluk³, Marcelo Oliveira³, Nicole Franco-León³, Paul Van Damme⁴, Elizabeth Campbell⁵, Joanna Alfaró⁶, Jeffrey Mangel⁷, Jose Luis Mena⁸, Saulo Usma⁹, Danni Parks¹⁰, Maria Jimena Valderrama¹, Estefany Acosta Lugo¹, Paula Torres-Forero¹, Dolores Armenteras-Pascual¹⁵

¹Omacha Foundation, Bogotá D.C, Colombia, ²Foundation Omacha, Bogotá, DC, Colombia, ³Departamento de Biología, Laboratorio de Ecología Funcional (LEF), Facultad de Ciencias, Pontificia Universidad Javeriana, Bogotá D.C., Colombia, ⁴Programa de Biología, Grupo de Investigación en Desarrollo y Estudio del Recurso Hídrico y el Ambiente (CIDERA), Facultad de Ciencias Básicas y Tecnologías, Universidad del Quindío, Armenia, Colombia., ⁵WWF Brazil, Brasília, Brazil, ⁶Fundación Omacha, Bogotá, D.C, Colombia., ⁷Fundacion Faunagua, Cochabamba, Bolivia, ⁸Prodelphinus, Lima, Peru, ⁹Prodelphinus, Lima, Peru, ¹⁰Pro Delphinus, Lima, Lima, Peru, ¹¹WWF, Lima, Peru, ¹²WWF Colombia, BOGOTA, DC, Colombia, ¹³Whitley Fund for Nature, London, United Kingdom., ¹⁴Universidad Militar Nueva Granada, Colombia, ¹⁵National University, Bogotá D.C, Bogotá D.C, Colombia

Although many studies have used linear models to demonstrate the dependence of various traits on body mass, its relationship with home range size has been perhaps the most difficult to understand. We investigated the linear relation between home range size and ecological predictors for 31 Amazon river dolphin individuals, monitored through satellite telemetry across eight river courses of these four in the Amazon basin and an equal number in the Orinoco basin. Home-range and core area sizes were calculated as the univariate kernel density estimates (KDE) at 95% (KDE95), and 50%, (KDE50) respectively; then a multivariate generalized linear mixed model (GLMM) including log mass and length and five other predictor variables (sex, number of location, tracking duration, longest distance, and elevation) were used to test a linear relation between ecological predictors and our spatial metrics. Interestingly, in our analyses, we did not
recover a statistically significant relationship between home range size and the Amazon river dolphin’s body mass and length. Additionally, among the seven analyzed predictors, only the longest distance showed a statistically significant relationship with home range size (p<0.001). Our results highlight the influencing ecological factors of the Amazon river dolphin home range and core area sizes, and who are being affected by human impacts on a regional scale in the Amazon, Orinoco, and Araguaia-Tocantins basins, such as operation and construction dams and their effect as physical barriers that also alter prey migratory processes and artificially regulating hydrological processes such as the flood pulses, a decrease of prey by overfishing, as well as habitat degradation due to gold mining, deforestation, and climate change.

Development of social behavior between mother and daughter in captive killer whales

Yoshihiro Motomura1, Tomohito Nakano2, Koji Kanda3, Mahiro Ryono3, Seiki Konno4, Mai Sakai5

1KINDAI University, 2Marine Mammal Research Laboratory, Nara-city, Nara, Japan, 3Port of Nagoya Public Aquarium, Minato-ku, Nagoya, Japan, 4Kamogawa SeaWorld, Kamogawa-city, Chiba, Japan, 5Kindai University, Nara, Japan

Killer whales live in matrilineal groups called pods in wild. Thus, mother and daughter relationships last for a relatively long time. The information regarding development of social interactions between mother and daughter are not well documented. We observed one mother-daughter pair of killer whales (Orcinus orca) at Port of Nagoya Public Aquarium, Japan to clarify the development of social behavior between them. We collected behavioral data for 48 days, over 5,642 minutes between September 2015 and November 2020 and recorded 2,076 social behaviors (bumping, biting, flipper rubbing, touching, and parallel swimming) between mother and daughter, primarily. Our results indicated that the frequency of contact behaviors (including biting, flipper rubbing, and touching) between mother and daughter gradually decreased with the growth of daughter. Contact behaviors with rostrum (8.4 episodes/h) were recorded more frequently than contact behaviors with flipper when the daughter was 2-3 years old. Following this, contact behaviors with flipper (4.4 episodes/h) became more frequent than those with rostrum when the daughter was 7-8 years old. This result showed that the main part of the body used during mother-daughter contact behaviors changed with daughter’s age. When the daughter was 7 years and 11 months old, we observed mother-daughter contact behavior to genital area more frequently than such behavior to other body parts. Additionally, we observed socio-sexual behaviors such as petting flipper to genital slit. We confirmed that the daughter was still nursing at the age of 8 years. Bumping behaviors are speculated to function as nursing requests from calves to mother. We observed 58 bumping behaviors, but only one of these was followed by nursing. These results suggested that bumping behaviors may have functions other than nursing requests.

Variation in cranial morphology between coastal and pelagic ecotypes of bottlenose dolphins (Tursiops spp.) worldwide

Nicholas Oxford-Smith1, Marcello Ruta1, Anli Gao2, Karine Viaud-Martinez1, Richard Sabin1, Jerry Herman2, John Ososky3, Yuko Tajima2, Tadasu K. Yamada7, Andre Moura8

1University of Lincoln, Lincoln, United Kingdom, 2University of Guelph, Guelph, 3Clinical Genomics Laboratory Services Illumina Inc., San Diego, 4Natural History Museum, London, United Kingdom, 5National Museums Scotland, Edinburgh, United Kingdom, 6Smithsonian Institution, Suitland, Maryland, 7National Museum of Nature and Science, Tsukuba, Ibaraki, Japan, 8Museum and Insitute of Zoology-PAS, Gdansk, Poland
Morphological differentiation between coastal and offshore bottlenose dolphins (genus *Tursiops*) has been researched since the 1960s, particularly in *T. truncatus* (Montagu, 1821). Although described for several locations worldwide, most studies have focused on geographically restricted comparisons. Therefore, it is unclear how such localized patterns integrate within the global morphological variation of this genus. Here we present results of a meta-analysis of global morphological variation between coastal and offshore *Tursiops*, using linear measurements (LM) of 488 specimens, and geometric morphometrics (GM) on 237 photographed specimens. Linear measurements were mostly obtained from previous studies, while photographs were taken specifically for this project. All linear measurements were compared through a PCA, while photographs were analysed following standard GM methods followed by a PCA.

Results show consistent skull shape differentiation between coastal and offshore ecotypes worldwide. Coastal ecotypes show substantial morphological variation and are well differentiated between regions, while pelagic ecotypes appear to show a more uniform morphological distribution worldwide. Most differentiation can be attributed to features dorsally, namely the rostrum area in the ascending processes of the maxilla (causing corresponding changes in skull width). These results suggest that skull shape in coastal *Tursiops* vary according to local regional differences, while pelagic ecotypes converge to a more uniform morphology worldwide. This likely reflects demographic independence between coastal areas, but also potential local environmental adaptations. Offshore environments appear to present stronger restrictions to shape variation relative to coastal suggesting stronger selective pressures, however this hypothesis requires confirmation from independent data.

**Assessing Remotely Piloted Aircraft Systems for Monitoring of Narwhal in the Canadian Arctic**

Geoff Mullins¹, Dustin Wales², Ainsley Allen¹, Mitchell Firman¹, Phillipe Rouget⁴

¹Aeria Solutions Ltd., Victoria, BC, ²Aeria Solutions Ltd., Squamish, BC, ³Golder Associates Ltd., Victoria, BC, ⁴Golder Associates Ltd., Victoria, British Columbia

The Canadian Arctic is a remote environment where weather can present unforgiving conditions for operating Remotely Piloted Aircraft Systems (RPAS). However, at the far reaches of the Canadian North, there are opportunities to study some of the most unique and dynamic systems on the planet. Monitoring is a critical component of marine mammal science for which RPAS have shown to be highly suitable. As with other marine megafauna, RPAS equipped with optical sensor packages allow for non-invasive monitoring of narwhal (*Monodon monoceros*) in their natural environment, including evaluation of fine scale behaviour amongst individuals and/or small social groups, and characterization of group composition and behaviour during large herding events or in areas of high density (i.e., calving grounds). Additionally, in this study laser range finding techniques and Real-Time Kinematic (RTK) positioning systems were utilized with calibrated targets to characterize system measurement accuracy and demonstrate the feasibility of measuring Narwhal with single image photogrammetry using a high-resolution variable zoom camera.

Permissions from the applicable Canadian Airspace regulators were secured for both high-altitude and Beyond Visual Line-of-Sight (BVLOS) flight operations and all RPAS flights undertaken in the field were performed jointly with experienced marine mammal biologists who were able to assess narwhal behaviour both in real-time and during the post-process/analysis stage. Data collected using this new tool has provided insight into nursing behavior of calves...
from their mothers, reproductive behaviours between conspecifics, and interactions amongst small social groups interacting at and below the surface. Preliminary results indicate that body size and condition measurements of narwhal are feasible using morphometric measurements obtained by the RPAS system in conjunction with the ground sampling calibrations for each lens/sensor/altitude combination. However, follow-up studies will be required to relate morphometric measurements to narwhal health metrics.

**Morphometric Analysis of Body and Appendage Size of the Deep Diving Gervais’ Beaked Whale (Mesoplodon europaeus)**

Laura Murley¹, D. Ann Pabst², Nathan Hirtle³, William McLellan⁴, Lesley Thorne⁵

¹University of Rhode Island, ²University of North Carolina, Wilmington, NC, ³Stony Brook University, ⁴University of North Carolina Wilmington, Wilmington, NC, ⁵Stony Brook University, Southampton, New York

Beaked whales of the Family Ziphiidae are deep and prolonged divers that display morphological, physiological and locomotory specializations that decrease their rate of energy use while diving. We investigated body and appendage sizes of Gervais’ beaked whale (*Mesoplodon europaeus*) and compared them to the short-finned pilot whale (*Globicephala macrorhynchus*). We hypothesize that at any given body size, Gervais’ beaked whales will possess a lower surface area to volume ratio (SA:V) than short-finned pilot whales, based upon the conceptual framework of Bergmann’s Rule. Because Gervais’ beaked whales experience prolonged exposure to cold temperatures during dives into the thermocline, which on average are deeper and longer than those of short-finned pilot whales, they would require a lower SA:V to decrease heat loss from the body. We also hypothesize that the surface areas of non-propulsive appendages (i.e., the dorsal fin, and pectoral flippers) will be smaller in Gervais’ beaked whales than in pilot whales to decrease heat loss, following Allen’s Rule. We used the open-source software Blender, to construct a 3D model of the core body and 2D models of the appendages of these two species, using methods similar to those of Adamczak *et al.* (2019). The appendage surface areas will be compared to those measured independently using Image Pro Plus. We are utilizing external morphometric data collected from Gervais’ beaked whales (n=25) and from short-finned pilot whales (n=72) that stranded along the US Atlantic. Blender modeling results for adult Gervais’ beaked whale indicate a mean SA:V ratio of 6.8/m (n=9; total body length 4.25-4.72 m); modeling of short-finned pilot whales is ongoing. The results of this study offer insights into how overall body and appendage size may affect thermoregulatory energetics across these deep diving species.

**Mom? Mom, is that you? A northern elephant seal pup’s ability to vocally recognize its mother in a densely populated rookery**

Molly Murphy¹, Caroline Casey², Gita Kolluru², Madeline Schroth-Glanz³, Heather Liwanag⁴

¹California Polytechnic State University - San Luis Obispo, San Luis Obispo, CA, ²UC Santa Cruz, Santa Cruz, California, ³California Polytechnic University, San Luis Obispo, CA, ⁴California Polytechnic State University, San Luis Obispo, California

Mutual parent-young recognition is important in species characterized by high densities at breeding sites, including pinnipeds. Vocal recognition has been studied extensively in pinnipeds that frequently separate from their pups to forage (otariids and a few phocids), but remains understudied in phocid seals that remain with their pups throughout the nursing period. Northern elephant seal (NES) mothers remain hauled out with their pup throughout the 28-day nursing period, in dense rookeries with as many as 100 females and dependents per harem. Pups
can easily become separated from their mothers during female-female aggression, inclement weather, and/or a male infiltrating the harem. The likelihood of a pup dying once separated from its mother is greatly increased, making recognition critical to pup survival, but little is known about NES mother-pup recognition. One recent study demonstrated that females can recognize their pup days after birth, but it is unknown if this recognition is mutual, and we hypothesize that it is. We are testing this by collecting focal recordings of adult female ACs for playback experiments at the Piedras Blancas NES rookery in San Simeon, CA. The playbacks include ACs of the pup’s own mother and ACs of an unrelated female from another beach. We are recording the pup’s behavioral responses to each playback, including vocalizations, phonotaxis, and head turns toward the speaker. Playbacks are performed three times throughout the nursing period to examine behavioral changes as the pup ages. Given that a pup separated from its mother has a lower chance of survival, we predict NES pups will respond significantly more to calls from their own mother than calls of another female. This study is the first to examine phocid pup vocal recognition abilities, and provides insight into a potentially life-saving strategy for young NES, as the effectiveness of mother-pup communication is unknown.

Tracking young of the year gray seals (Halichoerus grypus) to estimate fishery encounter risk
Kimberly Murray1, Josh Hatch1, Rob DiGiovanni2, Elizabeth Josephson3
1NOAA Fisheries, Woods Hole, MA, 2Atlantic Marine Conservation Society, 3Integrated Statistics, Woods Hole, MA

The level of annual incidental bycatch of gray seals (Halichoerus grypus) in the New England sink gillnet fishery is currently the highest of all marine mammals in the United States. One way to evaluate the risk of bycatch is to examine the risk of encounter between an animal and fishing gear based on the animal’s habitat use in relation to commercial fishing activity. Here we use satellite telemetry deployed on 30 gray seal pups in 2019 and 2020 to measure the risk of encounter with large mesh sink gillnet fishing effort throughout the Gulf of Maine and southern New England. We estimate relative encounter risk within 30 minute grid cells in each calendar quarter based on the overlap of seal presence and fishing effort, and then validate the expected risk based on bycatch events reported by independent observers on board fishing vessels. The relative risk of seals encountering gillnet fishing gear was highest off southeastern Massachusetts in spring. Patterns in the expected encounter risk fit our expectation that relatively higher levels of habitat use and fishing effort correspond to increased encounter risk. The approach taken here can be used to identify times and areas of high encounter risk to justify altered fishing practices for purposes of avoidance, or to guide monitoring intended to characterize and quantify bycatch. Mitigation strategies will need to be continuously monitored and updated to incorporate new information as conflicts with fisheries and gray seals are likely to continue.

A 3D Agent-Based Model Quantifying Anthropogenic Noise Impacts on Foraging SRKW
L. Scott Myers, University of Central Florida

This project uses an advanced 3D agent-based simulation model of individual Orcinus orca echolocating and foraging for Chinook salmon in order to understand anthropogenic noise impacts on the endangered Southern Resident Killer Whale (SRKW) population. The SRKW are under stress from decreasing prey and increasing anthropogenic noise from cargo ships and whale watching boats. Multiple field studies have been done on SRKW noise exposure, and several analytic models have been built about the noise, but to date none have been able to quantify
SRKW noise exposure and quantify any compensatory reactions to that noise which are important factors to consider before implementing noise-reduction policies. Earlier models did not actually simulate the orca, salmon, and boats all moving in 3D space pursuing their independent goals: the orca echolocating and trying to catch fish; the fish trying to avoid capture; whale watching boats shadowing the orcas on the surface; and cargo ships moving through the area. Our simulation model does all of that, and since sound detection is orientation-dependent we can track all those orientation-based noise interactions even as the relative positions change between the orca and noise emitters.

The U.S. and Canadian economies depend on the billions of dollars in commercial cargo that transits SRKW home waters. Laws like the MMPA seeks to preserve endangered marine populations, but management actions must also consider economic reality. Balancing these two goals requires a deft hand; we believe this model can help since it fuses DTAGs and boat noise field data, the physics of underwater sound, and 3D simulation into a cohesive decision support tool that can examine the current SRKW noise exposure, test “what-if” noise reduction policies for both cargo ships and whale watching boats, and provide guidance to management agencies in support of the of ecosystem-based management of endangered marine populations.

Listening for Killer Whales: Passive Acoustic Monitoring Reveals Year-round Distribution and Residency Patterns of Orcinus orca in the Northern Gulf of Alaska

Hannah Myers¹, Dan Olsen², Craig Matkin², Brenda Konar³

¹University of Alaska Fairbanks, Fairbanks, AK, ²North Gulf Oceanic Society, ³University of Alaska Fairbanks

Killer whales (Orcinus orca) are top predators in the North Pacific Ocean. The species is divided into three ecotypes—resident (primarily fish-eating), transient (mammal-eating), and offshore (largely shark-eating)—that are genetically and acoustically distinct and have unique roles in the marine ecosystem. Understanding killer whale distribution and habitat use patterns is important not only to inform effective management of this federally protected species, but also to provide insight into ecosystem functioning. In this study, we described the year-round distribution and daily residency patterns of killer whales across three locations in the northern Gulf of Alaska from fall 2016 to spring 2020 using passive acoustic monitoring. Highest overall acoustic presence occurred in Montague Strait in all years, with strong seasonal patterns of acoustic presence in Hinchinbrook Entrance and Resurrection Bay. Detailed inspection of one year of recordings assessed the daily acoustic residency times of each killer whale population and described characteristics of calling behavior. Daily acoustic residency times for the southern Alaska residents strongly supported seasonal distribution patterns, though residency times were substantially higher in Hinchinbrook Entrance in spring than at any other location or time. The majority of Gulf of Alaska transient detections also occurred in Hinchinbrook Entrance in spring. The depleted AT1 transient killer whale population was most often detected in Montague Strait. Acoustic detection rates were consistent across seasons, though there was some variation between killer whale populations. This study provided the first evidence of repeated stereotyped calls produced by Gulf of Alaska transients that could be used for passive acoustic monitoring of this infrequently sighted population. Passive acoustic monitoring revealed novel insights into high use locations and times for each killer whale population, which may be driven by seasonal foraging opportunities and social factors.

Bayesian trend analyses reveal a decline in...
harbour porpoise abundance in the North Sea over two decades

Dominik Nachtsheim¹, Sacha Viquerat², Nadya Ramirez-Martinez³, Bianca Unger⁴, Ursula Siebert⁵, Anita Gilles⁶

¹Institute for Terrestrial and Aquatic Wildlife Research, University of Veterinary Medicine Hannover, Büsum, Germany, ²University of Hamburg, ³University of St Andrews (SMRU), University of Veterinary Medicine Hannover Foundation (ITAW), Fundacion Macuaticos Colombia, Bogota, Colombia, ⁴Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover Foundation, Büsum, Schleswig-Holstein, Germany, ⁵Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Büsum, Schleswig-Holstein, Germany, ⁶ITAW - University of Veterinary Medicine Hannover Foundation, Büsum, Schleswig-Holstein, Germany

The North Sea is one of the most complex hotspots of anthropogenic stressors worldwide with a range of human impacts, including shipping, fisheries and oil and gas exploitation. Additionally, the increasing demand for space for renewable energy production is another massive anthropogenic impact affecting continental shelf species, such as the harbour porpoise (*Phocoena phocoena*). Being a key indicator species with a high conservation priority in the European Union (EU), all EU member states are obliged to assess its population status. Here, we estimate trends in absolute harbour porpoise abundance in the German North Sea using almost two decades of aerial line transect distance sampling surveys (2002-2019) with a special focus on three Natura 2000 Special Areas of Conservation (SACs). Trends were estimated for each SAC and two seasons (spring and summer) as well as the complete area of the German North Sea. For the trend analysis, we applied a Bayesian framework to a series of replicated visual surveys, allowing to propagate the error structure of the original abundance estimates to the final trend estimate. In general, harbour porpoise abundance decreased in northern areas and increased in the south, such as in the SAC Borkum Reef Ground. A particular strong decline with a high probability (94.9%) was detected in the core area and main reproduction site in summer, the SAC Sylt Outer Reef (-3.79% per year). The overall trend for the German North Sea revealed a decrease in harbour porpoise abundance over the whole study period (-1.79% per year) with high probability (95.1%). Considering the here seen trends in harbour porpoise abundance and anthropogenic stressors, it is imperative to better understand underlying drivers and causalities, also in a regional North Sea wide context, to form the basis for adaptive management.

North of Peru: A hotspot or hot stop for cetaceans?

Narda Nava-Villanueva¹, Carlos Francisco Yaipen-LLanos²

¹Organization for Research and Conservation of Aquatic Animals -ORCA PERU-, Surco, Lima, Peru, ²Organization for Research and Conservation of Aquatic Animals - ORCA PERU, Surco, Lima, Lima, Peru

The northern states of Peru comprised by Lambayeque, Piura and Tumbes, is the second most productive and densely populated areas in the coast, involving fisheries and tourism. However, little knowledge about their natural biology and lack of awareness towards their vulnerable condition still a considerable threat. Stranding causes recorded for cetaceans over two decades can provide critical data and a different approach to cetacean conservation, especially when local authorities do not get involved or there is a lack thereof. The aim of this presentation is to analyze cetacean strandings in northern Peru to identify the conservation trends needed for these species. This is a 20-year longitudinal, retrospective, descriptive study with coordinates for stranding locations, biometrics of
cetacean species, the cause of the strandings, and a timeline, where mass mortality events are not considered. 26 species of Odontocetes and 6 species of Mysticetes were compromised in 167 stranding incidences. Causes included 71% human and 29% non-human causes. A beach area in particular, San Jose of Lambayeque state has the largest cetacean stranding density 20.71% (N=169) within a timeframe that originally split in two seasons (summer and winter) but that today runs from February to August. The main cause of stranding was intentional catch reported in Delphinus delphis (26%). The role of cetaceans is known to influence the proper functioning of the ecosystem. Cetacean strandings, whether of natural or human causes, have a negative environmental impact overall, that is why it is important to use this trend and to serve as an input to identify those long-term threats for cetacean conservation. Today the challenge for Peruvians in the north is to embrace cetaceans in their natural space to share, protect and make the rights decisions with conservation initiatives if we are to keep cetacean species sharing those waters with future generations.

Where do they belong? Examining the blubber fatty acids of lactating harbor seals Victoria M. Neises¹, Shawna Karpovich², Mandy Keogh³, Stephen Trumble⁴
¹Baylor University, Robinson, Texas, ²Alaska Department of Fish and Game, Juneau, Alaska, ³NOAA Alaska Region, Juneau, AK, ⁴Baylor University, Waco, Texas

The harbor seal is known to have a lactation strategy intermediate to phocids and otariids, exhibiting a foraging cycle resembling otariids, while mirroring phocids in length of lactation, rate of mass gain in pups, and in milk fat content. The purpose of this study was to qualitatively investigate harbor seal blubber fatty acid profiles for conditional differences between lactating (n=20), pregnant (n=9), and non-lactating-non-pregnant females (n=40), as well as examine preferential fatty acid mobilization from mothers to pups. In addition, saturated, monounsaturated, and polyunsaturated blubber fatty acid proportions were compared to other lactating phocid and otariid species to determine if the intermediate lactation strategy exhibited by the harbor seal is reflected in its blubber fatty acid profile. PERMANOVA and LDA suggests lactating harbor seals are distinguished from pregnant and non-lactating-non-pregnant seals via saturated fatty acids (C18:0), while both pregnant and non-lactating-non-pregnant females are distinguished primarily by polyunsaturated fatty acids (C20:5n-3 and C22:6n-3), as well as saturated (C16:0) and monounsaturated (C16:1n-7) fatty acids. Analysis of six mother-pup pairs suggests the blubber profile of pups contains elevated levels of saturated and medium-chained monounsaturated fatty acids shorter than C18, while the blubber profile of mothers is significantly elevated in medium and long-chained monounsaturated and polyunsaturated fatty acids longer than C18. When compared across families, the blubber of lactating harbor seals most closely resembled previously reported saturated and monounsaturated fatty acid data for phocids. These results suggest lactating harbor seals may preferentially mobilize saturated and medium-chained monounsaturated fatty acids to their pups, while conserving mono and polyunsaturated fatty acids longer than C18 for their physiological requirements. In addition, relative proportions of blubber fatty acids appear to be conserved in the harbor seal when compared to other phocid species, despite exhibiting an intermediate lactation strategy, suggesting blubber fatty acids may be conserved among families.

The evolutionary history of manatees told by their mitogenome Mariana Nery, Campinas State University

The manatee family encompasses three extant congeneric species: Trichechus senegalensis
African manatee), T. inunguis (Amazonian manatee), and T. manatus (West Indian manatee). The fossil record for manatees is scant, and few phylogenetic studies have focused on their evolutionary history. We use full mitogenomes of all extant manatee species to infer the divergence dates and biogeographical histories of these species and the effect of natural selection on their mitogenomes. The complete mitochondrial genomes of T. inunguis (16,851 bp), T. senegalensis (16,882 bp), and T. manatus (16,882 bp), comprise 13 protein-coding genes, 2 ribosomal RNA genes (rRNA - 12S and 16S), and 22 transfer RNA genes (tRNA), and (D-loop/CR). Our analyses show that the first split within Trichechus occurred during the Late Miocene (posterior mean 6.56 Ma and 95% HPD 3.81–10.66 Ma), followed by a diversification event in the Plio-Pleistocene (posterior mean 1.34 Ma, 95% HPD 0.1–4.23) in the clade composed by T. inunguis and T. manatus; T. senegalensis is the sister group of this clade with higher support values (pp > 0.90). The branch-site test identified positive selection on T. inunguis in the 181st position of the ND4 amino acid gene (LRT = 6.06, p = 0.0069, BEB posterior probability = 0.96). The ND4 gene encodes one subunit of the NADH dehydrogenase complex, part of the oxidative phosphorylation machinery. In conclusion, our results provide novel insight into the evolutionary history of the Trichechidae during the Late Miocene, which was influenced by geological events, such as Amazon Basin formation.

El Niño Affects Reproduction and Survival of Humpback Whales in the Brazilian Breeding Ground

Mariana Neves¹, Leonardo Liberali Wedekin², Alexandre Zerbini³, Daniel Daniewicz³, Julio Baumgarten⁴, Paulo Inácio Prado⁶

¹Universidade do Estado do Rio de Janeiro, Rio de Janeiro, RJ, Brazil, ²Universidade de São Paulo, São Paulo, ³Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA, ⁴Grupo de Estudos de Mamíferos Aquáticos do RS, ⁵Applied Ecology and Conservation Lab, Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil, Ilhéus, BA, Brazil, ⁶LAGE do Departamento de Ecologia, Universidade de São Paulo, São Paulo, São Paulo, Brazil

The Southern Ocean is influenced by drastic climatic variability that affect many ecological processes at all trophic levels. Densities of Antarctic krill (Euphausia superba) are correlated with sea-ice cover and sea surface temperature, influencing their predators in different magnitudes and time lags. Understanding climate-driven effects on the reproductive success and survival of top marine predators is essential to predict how climate change may shape their populations. Using a 16-year time series of humpback whale (Megaptera novaeangliae) life history data from animals breeding off Brazil to investigate the relationship between birth rates and adult survival and climate variability. The potential effect of environmental variables (Southern Oscillation Index - SOI; NOAA’s Oceanic Niño Index - ONI; Southern Annular Mode index - SAM; and sea-surface temperature - SST) reflective of climatic anomalies in demographic parameters were evaluated using Generalized Linear Models (GLM) with Poisson error distribution (for birth index) and Comarck-Jolly-Seber capture-recapture (CJS) models (for adult survival). The most supported GLM model included the SOI with a 3-year time lag and suggested that high values of SOI, typical of La Niña events, lead to lower calf sighting rates in tropical Brazil after 3 years. Additionally, survival was affected by the SOI with lag of two years. The most supported CJS model predicted that adult survival is reduced two years after a La Niña event. El Niño-Southern Oscillation (ENSO) influences temperature and sea-ice-dynamics of the Southern Ocean, with consequences to abundance and transport of krill across this region. Our study suggests that the demographic
parameters of humpback whales are affected by climatic anomalies of ENSO, probably through changes in the availability of krill in the whale's feeding area.

**Breaking down “harassment” to characterize trends in human interaction cases in Maine’s pinnipeds**

Emma Newcomb¹, Kristina Cammen², Dominique Walk³, Holland Haverkamp¹, Lynda Doughty⁴, Sean Todd⁵, Rosemary Seton⁶, Lindsey Jones⁷

¹University of Maine, ²University of Maine, Orono, Maine, ³Marine Mammals of Maine, Bath, Maine, ⁴Marine Mammals of Maine, ⁵Allied Whale, College of the Atlantic, Bar Harbor, Maine, ⁶Allied Whale, College of the Atlantic, ⁷College of the Atlantic

Recent marine mammal recovery and the growth of human populations in coastal areas has led to increased opportunity for harmful human-wildlife interactions. For pinniped species, concern over the impact of human harassment in particular is growing. Current approaches to monitoring marine mammal-human interaction (HI) categorize “harassment” broadly and lack the resolution necessary to describe potential impacts on pinniped population health and design effective mitigation programs. We therefore propose a new HI classification scheme, which defines subcategories of harassment based on the type of human behavior and associated risks to the animal. We apply this new scheme to a spatiotemporal analysis of harbor (*Phoca vitulina*), harp (*Pagophilus groenlandicus*) and gray (*Halichoerus grypus*) seal strandings (N = 3,525) from 2007 to 2019 in Maine, United States. Evidence of HI was reported in 14.72% of strandings, with the majority (75.34%) of these cases involving harassment. The number of HI reports increased over time, particularly in the southern region of the state, which has the highest density of human populations, reported pinniped strandings, and HI cases. Geographic hotspots of higher than expected proportions of HI cases, which serve as indicators for emerging areas of concern, were more broadly distributed across the state. Variation in the rate and type of HI among species, age classes, and seasons reflect differences in life history of the affected pinniped species. The most commonly observed types of harassment included human approach, physical contact and displacement. By breaking down harassment, we aim to inform ongoing efforts to mitigate HI, contribute to our understanding of the potential impact of HI on marine mammal health in a region that has experienced recent growth in coastal human and pinniped populations, and offer a methodological approach that is transferable to regions elsewhere that are experiencing parallel growth and human-wildlife interaction

**The k-least cost path algorithm as a novel whale ship strike mitigation and vessel routing tool**

Lisa Neyman¹, Nathan Crum²

¹Florida Fish and Wildlife Conservation Commission, ²Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, St. Petersburg, Florida

Ship strikes are a serious and pervasive threat to whales in US waters and internationally, with approximately 1200 cases documented by the International Whaling Commission as of May 2016. Vessel routing measures are used to mitigate ship strike risk by reducing the spatial overlap between ship traffic and whales. Such routing measures have successfully been implemented in the southeastern US and Cape Cod Bay for the North Atlantic right whale, and through the Channel Islands for blue, fin, and humpback whales. Often vessel routing measures are designed based on a comparison of a small number of candidate routes. The *k*-least cost path algorithm (KLCP) provides an alternative routing technique that allows for the exploration of all possible routes subject to desired constraints. The
KLCP algorithm is an extension of least cost path modeling that finds the $k$ shortest paths or routes in a network and can incorporate ship strike risk estimated using an encounter theory risk framework. In this application, the network describes the travel time, distance, or ship strike risk associated with traveling along a path across the study area and allows the user to identify all paths with shorter travel times, distances, or lower ship strike risk than a set threshold value.

The KLCP algorithm is easily modified for use in designing new routing measures or for evaluating existing ones, can be applied anywhere where relevant spatially explicit abundance estimates are available, can handle a variety of path constraints, and is not species or vessel type specific. This versatility and the ability to analyze a multitude of paths make the KLCP approach a robust and viable option for managers working to mitigate whale ship strike risk.

**Taxonomic assessment using multiple lines of evidence in Tursiops and Delphinus spp.**

Sibu Ngqulana¹, Michael Christiansen², Anders Galatius³, Paula Hedley³, Rus Hoelzel⁴, G. J. Greg Hofmeyr⁵, Pierre Pistorius⁶, Stephanie Plön⁷

¹Port Elizabeth Museum @ Bayworld, South Africa, ²Copenhagen, Denmark, ³Aarhus University, Department of Bioscience, Roskilde, Denmark, ⁴Durham University, Durham, United Kingdom, ⁵Port Elizabeth Museum at Bayworld, Port Elizabeth, South Africa, ⁶Nelson Mandela University, Port Elizabeth, South Africa, ⁷Stellenbosch University, South Africa, South Africa

Authors such as Wang et al. 2000, have discussed that some taxonomic treatments may not be as straightforward and may then require other approaches for assessing available information and classification. This was found true for this study, which provided a taxonomic assessment of Tursiops and Delphinus off South Africa, using different lines of evidence, including molecular analysis, cranial and external morphology analyses. The use of these analyses provided strong evidence of the presence of the two species of Tursiops off South Africa, as the cranial and external morphology results reflected results from the molecular analysis. On the contrary, these analyses did not reflect the same results for Delphinus spp.. Furthermore, the results from the different analyses could complement one another as they did with Tursiops spp. Each analysis reflected different patterns which clearly suggested that morphology in this genus does not reflect genetic differences. Perhaps, the differences between the two patterns of phylogenies of these genera are due to differences in the rate and patterns of evolution. It has been suggested that slower evolving mtDNA loci could be used successfully in species delineation. Rapid radiation might be a reason for incongruency between the lines of evidence used in this study, for Delphinus spp.. Other factors, such as differences in the completeness lineage sorting and introgression in mtDNA phylogenies could be another reason for the different taxonomic patterns between the two genera.

**Dolphins as part of the ecological character of Ramsar-listed wetlands: a case study of Indo-Pacific bottlenose dolphins in the Peel-Harvey Estuary, Western Australia**

Krista Nicholson¹, Neil Loneragan², Hugh Finn³, Lars Bejder⁴

¹Murdoch University, Innaloo, Western Australia, Australia, ²Murdoch University, Murdoch, Western Australia, Australia, ³Curtin University, Bentley, Australia, ⁴Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, Hawaii, HI

Whether dolphins are part of the ecological character of Ramsar-listed wetlands depends on their status as a biological component of the ecosystem (e.g., dolphin biomass, residency) and their involvement in ecosystem processes (e.g.,
energy and nutrient dynamics, species interactions). The aim of this study is to provide the scientific basis for deciding whether Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in the Peel-Harvey Estuary (PHE) in Western Australia should be considered part of the ecological character of the Ramsar-listed Peel-Yalgorup wetland system that the PHE is a part of. Dolphin photo-identification and behavioral data, as well as tissue samples, were collected during boat-based surveys in the PHE and adjacent coastal waters between 2016 and 2019. Social, spatial and isotopic ($\delta^{13}$C and $\delta^{15}$N) niche partitioning were investigated to identify population structure based on biologically meaningful criteria. Social structure, home range and stable isotope analyses confirmed a year-round resident, socially, spatially and isotopically distinct community of ~90 dolphins occupying the PHE. The estuarine community had a slightly negative population growth rate (-0.004, SD 0.062) with a low probability (0.010, SE 0.003) of extinction in 100 years. The community was closed to immigration, with changes in abundance driven by births and deaths and likely permanent emigration of immature males. Social clusters within the community were heterogeneous in their space use and diet. Detritivores, omnivores and herbivores and benthic omnivores and carnivores each contributed approximately a third and water column species 10%, to the annual fish biomass (>200,000 kg) removed by the resident dolphin community. The findings of this study provide strong empirical evidence that dolphins are a functional biological component of the ecological character of the Peel-Yalgorup Ramsar site.

A long post-reproductive lifespan in some mammals remains an evolutionary puzzle. Theory predicts demographic patterns resulting in increased female relatedness with age (kinship dynamics) can select for a prolonged post-reproductive lifespan due to the combined costs of inter-generational reproductive conflict and benefits of late-life helping. Here we examine the link between kinship dynamics and life history evolution by comparing post-reproductive lifespans between sympatric yet genetically distinct resident and Bigg’s killer whale ecotypes. Both are predicted to show an increase in female relatedness with age, the increase however, is predicted to be steeper in residents due to differences in social structure between the ecotypes. Using >40 years of demographic data we show that both ecotypes have a significant post-reproductive lifespan with >30% of adult female years being lived as post-reproductive, supporting the general prediction that an increase in local relatedness with age predisposes the evolution of a post-reproductive lifespan. Differences in the magnitude of kinship dynamics however, did not influence the timing or duration of the post-reproductive lifespan with females in both ecotypes terminating reproduction before their mid-40s followed by an expected post-reproductive period of ~20 years. Our results highlight the important role of kinship dynamics in the evolution of a long post-reproductive lifespan in long-lived mammals and suggest that a long post-reproductive period may be an ancestral trait in killer whales.

Seal watching in Lake Saimaa
Marja Niemi1, Milaja Nyykänen1, Vincent Biard1, Mervi Kunnasranta2
1University of Eastern Finland, Joensuu, Finland, 2University of Estern Finland, Joensuu, Finland

The endangered ringed seal (*Pusa hispida*)

---

Mia Nielsen, University of Exeter, EXETER, United Kingdom

The extended female post-reproductive lifespan in some mammals remains an evolutionary puzzle. Theory predicts demographic patterns resulting in increased female relatedness with age (kinship dynamics) can select for a prolonged post-reproductive lifespan due to the combined costs of inter-generational reproductive conflict and benefits of late-life helping. Here we examine the link between kinship dynamics and life history evolution by comparing post-reproductive lifespans between sympatric yet genetically distinct resident and Bigg’s killer whale ecotypes. Both are predicted to show an increase in female relatedness with age, the increase however, is predicted to be steeper in residents due to differences in social structure between the ecotypes. Using >40 years of demographic data we show that both ecotypes have a significant post-reproductive lifespan with >30% of adult female years being lived as post-reproductive, supporting the general prediction that an increase in local relatedness with age predisposes the evolution of a post-reproductive lifespan. Differences in the magnitude of kinship dynamics however, did not influence the timing or duration of the post-reproductive lifespan with females in both ecotypes terminating reproduction before their mid-40s followed by an expected post-reproductive period of ~20 years. Our results highlight the important role of kinship dynamics in the evolution of a long post-reproductive lifespan in long-lived mammals and suggest that a long post-reproductive period may be an ancestral trait in killer whales.

---

Seal watching in Lake Saimaa
Marja Niemi1, Milaja Nyykänen1, Vincent Biard1, Mervi Kunnasranta2
1University of Eastern Finland, Joensuu, Finland, 2University of Estern Finland, Joensuu, Finland

The endangered ringed seal (*Pusa hispida*)
saimensis) lives landlocked in Lake Saimaa, Finland, with an estimated population size of ~400 individuals. These seals undergo an annual molt in the spring when they are hauled out on rocks. During this time, it is relatively easy for locals and tourists’ companies to offer seal watching trips. We interviewed 10 companies related to seal watching to gain quantitative understanding on their operation and practices. In addition, to assess the effects on the behaviour of the seals, boat traffic was monitored with camera traps set in six seal haul-out locations. Based on our interviews, operators were aware of the seal conservation issues and many have taken part to the volunteer-based seal monitoring. The camera traps recorded 19 haul-out days. The maximum number of boats recorded over one day at one seal haulout was five, four of which were dedicated tourism boats. The overall number of boats visiting the sites was low, averaging at <1 per day. Most of the seal watching occasions (n=17) did not show adverse effects on seal behaviour. However, we observed two occasions that led to seals leaving the rock after a close approach by a boat, one of them being dedicated tourism boat. On one of these occasions, the seal did not return to the site that day. It is possible that the observed seals have become habituated to the presence of vessels as the locations are popular among tourism boats. Based on the interviews, private boaters are seen to cause more disturbance for the seals, which is also highlighted in the seal behavior results. Information on how to conduct sustainable seal watching should therefore be targeted especially to independent travellers more effectively.

Morbidity and mortality patterns of Indian River Lagoon bottlenose dolphins (Tursiops truncatus) 2002-2020
Wendy Noke-Durden¹, Teresa Jablonski², Megan Stolen³, Connie Silbernagel⁴, David Rotstein⁵, Judith St. Leger⁶
¹Hubbs-Sea World Research Institute, Melbourne Beach, FL, ²Hubbs-SeaWorld Research Institute, Melbourne Beach, FL, ³Hubbs-SeaWorld Research Institute, Melbourne Beach, Florida, ⁴Marine Mammal Pathology Services, Olney, Maryland, ⁵Sea World San Diego, San Diego, CA

The examination of mortality patterns in cetaceans is critical to understanding population health. Bottlenose dolphins (Tursiops truncatus) residing in the Indian River Lagoon (IRL), Florida have been subjected to four Unusual Mortality Events in recent years (2001, 2008, 2013, 2013-2015), highlighting the need to evaluate patterns of morbidity and mortality. From 2002-2020, complete gross examinations were conducted on 392 stranded IRL dolphins and histopathological analyses were conducted for 178. Significant causes of mortalities were grouped by etiology: degenerative, anomalous, metabolic, nutritional, inflammatory (infectious and non-infectious), and trauma. Significant causes of stranding were evident in 57% of cases (225/392). Despite a complete examination, significant cause of stranding was not evident in 43% of cases. Inflammatory disease and trauma were the most common causes of mortality, with pneumonia and anthropogenic activities (entanglement, fishing gear/foreign debris ingestion, propeller strikes) representing the most common causes, respectively. Natural trauma (prey-associated esophageal obstruction/asphyxiation, shark bites, and stingray interactions) and trauma of undetermined causes also contributed to stranding events. Significant cause of stranding varied annually, with nutritional cases peaking during the 2013 UME and infectious during the morbillivirus epidemic in 2014. This study represents the most comprehensive evaluation of morbidity and mortality patterns in IRL dolphins. IRL dolphins are routinely exposed to anthropogenic threats and have endured multiple Unusual Mortality Events. Therefore, these baseline data are critical to the conservation and management of this population.
The Use of Muscle Lipid, Nitrogen, and Carbon Content as Markers for Body Condition and Health and the Importance of Muscle Energy Stores During Periods of Reduced Prey Acquisition in Killer Whales
Dawn Noren1, Ylitalo Gina1, Stephen Raverty2, Todd Robeck3, Jonelle Gates4
1NOAA NMFS NW Fisheries Science Center, Seattle, Washington, 2The Animal Health Center, Abbotsford, British Columbia, 3SeaWorld and Busch Gardens Reproductive Research Center, San Diego, CA, 4Environmental Fisheries and Sciences Division, Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, Washington 98112, USA

Multiple stressors affect cetacean health and foraging success, potentially depleting body energy stores. Blubber thickness, blubber lipid content, and morphometric body condition indices (BCI) are used to evaluate health and nutritional status in cetaceans. However, blubber serves other roles, including thermoregulation and buoyancy, thus the utilization of this energy store may be limited. Muscle lipid and protein may serve as additional energy sources in diseased or prey-limited individuals. Therefore, muscle biochemical signatures may be better indicators of health and body condition in stranded cetaceans, especially since BCIs and blubber integrity are rapidly impacted by post-mortem decay. Because muscle lipid content, C:N ratio, δ15N, and δ13C varies with nutritional state in other vertebrates, we quantified lipid content, C:N, δ15N, and δ13C in muscles collected from deceased killer whales (16 wild stranded, 4 in human care). Expectedly, δ15N correlates with body length (r=-0.74, P<0.001), and both δ13C and δ15N vary by killer whale ecotype/habitat (both P≤0.01). Muscle lipid content increases with body length (r=0.50, P=0.02) and BCI (girth at the anterior dorsal fin insertion/straight body length, r=0.55, P=0.02) but does not vary by ecotype/habitat. Neither C:N nor BCI correlates with body length, and neither varies by ecotype/habitat. C:N tends to increase with BCI (r=-0.42, P=0.09) and is positively correlated with muscle lipid content (r=0.81, P<0.001). Both C:N and lipid content vary by cause of death (trauma, infection, malnutrition; P<0.05). Killer whales that perished from trauma had the greatest muscle lipid content and C:N, while malnourished individuals had the lowest values. These results show that muscle lipid and protein are used to meet energetic demands in unhealthy killer whales and are particularly depleted in starved animals. Finally, muscle biochemical signatures may outperform BCIs and blubber thickness measurements as tools to evaluate body condition and discriminate between acute and chronic disorders in stranded odontocetes.

A systematic review demonstrates how surrogate populations help inform conservation and management of an endangered species – the case of Cook Inlet, Alaska belugas
Stephanie Norman1, Lindsay Dreiss2, Talia Niederman2, Katy Nalven3
1na, 2Center for Conservation Innovation, Defenders of Wildlife, 3Defenders of Wildlife, Anchorage, Alaska

The genetically and geographically isolated Cook Inlet beluga (CIB) was listed as endangered (2008) and given a federal Recovery Plan (2016). Nonetheless, CIB have failed to demonstrably progress towards recovery. There are data and knowledge gaps regarding the impact and severity of identified threats on CIB health and recovery, particularly for anthropogenic factors. These data deficiencies may hinder prioritizing threats and conservation/management actions. Odontocetes in similarly ecologically precarious situations may serve as research surrogates to fill information gaps and guide future CIB research and conservation. Through a systematic literature review of CIB and surrogate species [St. Lawrence beluga (SLB), Hector’s dolphins (HD),
and southern resident killer whales (SRKW)], using the PRISMA approach, 1975-2020, we identified data gaps associated with threats described and ranked in the CIB Recovery Plan. A total of 789 records were retained from the search results after applying inclusion criteria and removing duplicates. The number of publications for threats identified by the CIB Recovery Plan as ‘high’ concern, except noise, were fewer compared to ‘high’ concern threats in SLB and SRKW. Select ‘medium’ or ‘low’ threats to CIB, such as contaminants and prey reduction, were classified as higher priority threats in surrogate populations. These threats have been more heavily investigated in surrogate populations and may suggest that synthesis of surrogate study findings may help reduce uncertainty to aid in informing CIB management actions. Specifically, publication volume suggests that SLB and SRKW are valuable surrogates for understanding the impacts of threats to CIB. We use this review to offer management recommendations based on current CIB and surrogate literature regarding listed threats in the CIB Recovery Plan. We propose there is just cause, through the wealth of surrogate literature, to revise and elevate some low and medium concern threats to CIB such as contaminants, habitat degradation, and prey reduction.

Update on the Guadalupe fur seal Unusual Mortality Event in the United States, 2015-2020

Tenaya Norris¹, Deborah Fauquier², Denise Greig³, Sue Pemberton¹, Justin Greenman⁶, Justin Viezbicke⁶, Kristin Wilkinson⁴, Dyanna Lambourn⁴, Jim Rice⁴, Christina Fahy¹⁰, Sarah Wilkin¹¹, Teresa Rowles¹²

¹Kentfield, California, ²NOAA Fisheries, ³California Academy of Sciences, San Francisco, California, ⁴California Academy Of Sciences, San Francisco, ⁵NOAA Fisheries, Long Beach, CA, ⁶NMFS, Portland, OR, Oregon, ⁷NOAA Fisheries, Protected Resources Division, Seattle, ⁸Washington, ⁹Washington Department of Fish and Wildlife, Olympia, Washington, ¹⁰Oregon State University, Newport, Oregon, ¹¹National Marine Fisheries Service, Long Beach, California, ¹²National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD, ¹³Silver Spring, Maryland

Anomalously warm waters, or marine heatwaves, have persisted across the Northeast Pacific Ocean in recent years and caused unprecedented ecosystem-level effects, including dramatic shifts in species distribution and abundance as well as mass strandings and mortality events. In the California Current System, the most severe marine heatwaves on record were in 2014-2016 and 2019-2020. National Marine Fisheries Service declared Unusual Mortality Events (UME) for several marine mammal species in this region over the last decade, including Guadalupe fur seals (GFS; Arctocephalus philippii townsendi), which is classified as a threatened species in the U.S. and endangered in Mexico. The GFS UME began in California in 2015, expanded to include strandings in Oregon and Washington in 2019, and is ongoing as of April 2021. From 2015-2020, a total of 492 GFS stranded in California, with a minimum annual total in 2018 (n = 45) and a maximum annual total in 2019 (n = 116) compared with 9 ± 3 seals/year from 2005-2014. In addition, 133 GFS stranded in Oregon and Washington in 2019 (n = 91) and 2020 (n = 42), resulting in a total of 625 stranded seals included in this UME investigation (2015-2020), which would not have been accomplished without the response, collaboration, and dedication of the marine mammal stranding networks in California, Oregon, and Washington. Strandings of both live and dead GFS were seasonal, peaking April-June each year. The majority of animals (~97%) were emaciated pups and yearlings (<2 years old). Other health findings included entanglements, bacterial and parasitic infections, domoic acid intoxication, anemia, and alopecia. Reduced prey availability likely is the primary cause of this
GFS UME, and as a shallow-diving, pelagic species that primarily feeds on squid, GFS may be particularly vulnerable to marine heatwaves, especially those that remain farther offshore as was the case in 2019-2020.

Adult grey seals exhibit repeatability of movement patterns and interannual foraging site fidelity in an oceanographically variable ecosystem

Benia Nowak¹, Don Bowen², Nell den Heyer³, Damian Lidgard⁴
¹Dalhousie University, Halifax, ²Bedford Institute of Oceanography, Halifax, Nova Scotia, ³Bedford Institute of Oceanography, Dartmouth, Nova Scotia, ⁴Dalhousie University, Halifax, Nova Scotia

Interannual repeatability in foraging behavior may be expression of foraging specialization at a large spatial and long temporal scales. Long-term fidelity to foraging regions in variable environments may confer ecological benefits to individuals, such as familiarity with resources, even when energy gain is not consistently high in all years. Relatively little is known about foraging site fidelity in pinnipeds. Grey seals are an abundant and increasing upper-trophic level predator exhibiting associations with oceanographic conditions and frequently consumed prey. We studied foraging site fidelity in grey seals at Sable Island. 21 (16 female, 5 male) adults were instrumented with satellite-linked (1995-2004) and GPS (2009-2018) tags in multiple years. Of the 46 tracks available, 17 individuals had two tracks and four had three tracks. Repeated tagging occurred between three and 19 years apart. To assess the repeatability of habitat use, we fitted a state-space model (to Argos data) and a hidden Markov model (to Fastloc GPS data) to estimate behavioural states classified as directed movement and apparent foraging. We then compared the number, size, and residence time at foraging patches and assessed the spatial variability of foraging patches using a spatial grid as a measure of foraging site fidelity. We also compared the spatial variability of overall movement patterns at broader scales. Our results indicate that adults showed foraging site fidelity among years. The number, size, and residence time of foraging patches for individuals varied slightly among years. However, the spatial variability in both the movement patterns and locations of foraging patches remained low for most individuals, regardless of the number of years between being tagged. Although our results clearly indicate that adults of both sexes exhibit foraging site fidelity among years, when this fidelity is established and how it is influenced by interannual environmental variability remains to be determined.

Effects of Winter Storms and Oceanographic Conditions on Survival to Weaning: A 37-Year Study of Northern Elephant Seals on the Farallon Islands

Nadav Nur¹, Ryan Berger², Derek Lee³, Pete Warzybok⁴, Jaime Jahncke⁵
¹Point Blue Conservation Science, Santa Rosa, CA, ²The Marine Mammal Center, Sausalito, CA, ³Pennsylvania State University, ⁴Point Blue Conservation Science, Petaluma, California, ⁵Point Blue Conservation Science, Petaluma, CA

Northern elephant seals (Mirounga angustirostris) were extirpated from California in the 19th century, and only in recent decades have they recolonized. A key demographic parameter underlying population viability, in the face of threats such as climate change, is the survival of pups, from birth to weaning. We evaluated local factors acting directly on pup survival prior to weaning and basin-wide factors reflecting oceanic conditions, which may impact maternal condition and behavior, using a 37-year time series from two adjacent islands: Southeast Farallon Island (SEFI) and West End Island (WEI). Analysis of pup survival using mixed effects logistic regression indicated that annual
pup survival decreased with increasing frequency of extreme waves during January and February, which may inundate haulout locations when pups are present. This interpretation was confirmed analyzing mean high water (MHW) levels: the greater the monthly MHW, the lower was pup survival. Moreover, the impact of extreme waves and high water levels was manifest only for WEI, which may reflect greater exposure of pups to extreme waves on WEI compared to SEFI. Annual pup survival increased with the North Pacific Gyre Oscillation (NPGO) index, reflecting increased primary productivity. Pup survival was highly correlated with NPGO values during the months including arrival and occupancy of haul out locations (“winter”) as well as with NPGO values during the previous spring and summer, when females that have pupped forage to regain body mass. Impacts of extreme waves on pup survival is of concern since the frequency and severity of storms is expected to increase in the future, which may prevent population recovery or lead to population declines. To facilitate population recovery we recommend studies consider additional demographic parameters such as recruitment of females to the Farallon breeding population and to adjacent coastal California colonies.

A Gut Feeling: DNA Metabarcoding of Prey Species from Fecal Samples of Gray Whales in the Pacific Coast Feeding Group

Charles Nye1, Debbie Steel2, Lisa Hildebrand3, Leigh Torres4, C. Scott Baker5

1Oregon State University, Newport, Oregon, 2Fisheries and Wildlife Department and Marine Mammal Institute, Oregon State University, Newport, OR, 3Marine Mammal Institute, Oregon State University, 4Marine Mammal Institute, Oregon State University, Newport, OR, 5Marine Mammal Institute, Oregon State University, Newport, OR

Gray whales (Eschrichtius robustus) in the Pacific Coast Feeding Group (PCFG) forage in nearshore waters along the coasts of northern California, Oregon, Washington, and British Columbia during the summer months. These whales, which can be individually identified from unique markings, employ diverse foraging behaviors to capture a wide variety of nearshore zooplankton prey species. Conventional methods to identify gray whale prey include direct observations of foraging, epibenthic or benthic sampling, and stomach contents from necropsies. Noninvasive mtDNA metabarcoding of genetic material harvested from fecal plumes allows for multiple “snapshots” of an individual whale’s diet. Here, we present initial metabarcoding results of 15 fecal samples collected from PCFG gray whales off the Oregon coast. A 114-140 base pair fragment of the metabarcoding gene 16S rRNA was amplified and sequenced on a MiSeq platform, providing an average of 11,499 reads per sample. The reads were aligned with the program dada2 and assigned taxonomy via GenBank (BLAST). Off-target and gray whale reads were removed bioinformatically, resulting in a post-processing average of 3,992 reads per sample. 36 distinct taxa were identified to species-level across 7 phyla (average Shannon-Wiener H: 0.76). Diet composition varied considerably between individual whales (PERMANOVA: F = 1.82, p = 0.002). The vast majority of reads aligned to marine arthropods primarily within clades Branchiopoda and Malacostraca; uncommon taxa included arrow worms, gastropods, and echinoderms. While these results support prior research indicating marine arthropods as primary prey for gray whales, other suspected PCFG prey species, including mysids (e.g., Neomysis sp.), were only represented in trace read quantities. Additional sample processing and the inclusion of additional metabarcoding markers will be conducted to reconcile these early results. As changing conditions and human activity continue to affect the Oregon coastal environment, an understanding of the PCFG’s ecological interactions is integral for conservation efforts.
Repatriation of a historical North Atlantic right whale habitat during an era of rapid climate change
Orla O’Brien¹, Daniel Pendleton², Laura Ganley³, Katherine McKenna¹, Robert Kenney⁴, Ester Quintana-Rizzo⁶, Scott Kraus⁷, Jessica Redfern²
¹Anderson Cabot Center for Ocean Life at the New England Aquarium, Rockland, MA, ²Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, Massachusetts, ³Burlington, Massachusetts, ⁴Anderson Cabot Center for Ocean Life at the New England Aquarium, ⁵University of Rhode Island, Graduate School of Oceanography, Narragansett, RI, ⁶Simmons University, ⁷New England Aquarium, Boston, MA

Climate change is affecting species distributions in space and time. In the Gulf of Maine, among the fastest-warming marine regions on Earth, rapid warming has caused changes to the zooplankton species’ assemblage and phenology. These changes, in turn, have altered the distribution of the critically endangered North Atlantic right whale (Eubalaena glacialis), which feeds on zooplankton. Right whales have returned to historically important areas such as southern New England shelf waters (SNE), an area known to have been a whaling ground, but one that has not been known to host large numbers of right whales in modern times. While whales are known to occur in SNE, the relative importance of this region is still being assessed. We compared aerial survey data from two time periods (2012-2015; 2017-2019) to assess the trends in right whale abundance in SNE during winter and spring. We used distance sampling techniques to model right whale detection and estimate density and abundance. We chose a hazard rate key function to model right whale detections and used seasonal encounter rates to estimate abundance. We found a significant increasing trend in right whale habitat use of the area by using both a generalized linear model inversely weighted by the squared coefficient of variation (p < .01) and a linear model using the number of unique whales corrected for effort (r² = 0.73, p < .001). These results show the current importance of this habitat and suggest that management options must be continually evolving as right whales repatriate historical habitats and potentially expand to new habitats in the face of climate change. Sources of risk in these areas need to be managed to ensure the survival of the species.

New approach for neurotoxicity assessment using neurons directly reprogrammed from whale fibroblasts
Mari Ochiai¹, Hoa Thanh Nguyen³, Nozomi Kurihara³, Masashi Hirano¹, Yuko Tajima³, Tadasu K. Yamada⁵, Hisato Iwata²
¹Center for Marine Environmental Studies (CMES), Ehime University, Matsuyama, Japan, ²Center for Marine Environmental Studies, Ehime University, Matsuyama, Japan, ³Utsunomiya University, Utsunomiya-shi, Tochigi, Japan, ⁴Department of Bioscience, School of Agriculture, Tokai University, ⁵National Museum of Nature and Science, Tsukuba, Ibaraki, Japan

Toothed whales are vulnerable to the bioaccumulation of environmental contaminants through the food web. Cetaceans may suffer from adverse effects of polychlorinated biphenyls (PCBs) and their hydroxylated metabolites (OH-PCBs) exposure including neuronal dysfunction. However, it is difficult to perform neurotoxicity tests on cetaceans as the opportunities to collect living neurons, if any, are extremely rare. To address this knowledge gap, this study successfully established neurons directly reprogrammed from mass stranded melon-headed whales (Peponocephala electra), and applied them to in vitro neurotoxicity assays. Fibroblasts were isolated from muscle and kidney tissues of four individuals, and passaged several times before neural induction. Induced neurons (iNCs)
were directly reprogrammed from the fibroblasts, by adding a cocktail of six small molecules to neural induction medium. Neural induction efficiencies of whale iNCs were compared with those of human iNCs which were also directly reprogrammed, and both iNCs showed similar neural marker expression patterns. Neuronal markers (Tuj-1 and MAP-2) were positive for both species, but glial cell markers (GFAP and CNPase) were both negative. Apoptosis assays with an anti-cancer drug, cisplatin, and an OH-PCB congener, 4-OH-2',3,5,5'-tetrachlorobiphenyl (4'OH-CB72), revealed that whale iNCs were more sensitive to these compounds than human iNCs. Transcriptome analysis was applied to characterize the changes of gene expression induced by direct reprogramming and the potential toxicity of 4'OH-CB72 exposure on whale and human iNCs. Functional enrichment analysis showed that expressions of genes related to extracellular matrix and focal adhesion that are critical for neurogenesis were significantly altered by direct reprogramming. Additionally, genes associated with oxidative phosphorylation, chromatin degradation, axonal transport, and neurodegenerative diseases were altered by 4'OH-CB72 exposure. These results suggest that exposure to 4'OH-CB72 may induce apoptosis and neurodegeneration in whale neurons. Our non-invasive approach to obtain neurons is useful for assessing the neurotoxicity of environmental pollutants on marine mammals.

Harbor seals’ (Phoca vitulina) visual cognition: How they use brightness and shape to discriminate objects?
Monica Ogawa1, Yoko Mitani2, Ayako Momoï3, Toshihiko Kushihiki1
1Hokkaido University, Environmental Science, Hakodate, Hokkaido, Japan, 2Kyoto University, Hokkaido, Japan, 3Asamushi Aquarium, Japan

Visual cognition have different characteristics depending on the species, and have evolved independently as each species adapted to their living environment. When animals visually discriminate objects, they use shape and brightness (color) information comprehensively, and is said that which information is prioritized for discrimination may be different depends on habitat. Previous studies have revealed that seals are very sensitive to brightness difference and can discriminate in objects which have complex shape and brightness, but actual mechanism of how they discriminate in objects is unknown. We conducted experiment with five housed harbor seals (Phoca vitulina) to clarify how amphibious animals use these two information. Subjects are trained in a two-alternative forced choice task to discriminate between a dark grey circle (positive rewarded object) and a light grey triangle. In test phase, in addition to two objects used in training, we used two novel objects (dark grey triangle, light grey circle). Two of four objects were randomly presented to subjects and the selection rates of each object were compared. We found that harbor seals discriminate objects based on shape (circle) rather than brightness (dark grey). This may be because brightness can be vulnerable information for amphibious animals as brightness contrast reduce drastically underwater. Our study indicated that seals may have adapted to use shape information that universal regardless of the amount of light rather than brightness in discriminating objects. This is the first study that revealed visual discrimination process of harbor seals.

Isotope-n your eyes: Revealing the diet of the critically endangered Māui dolphin using stable isotope analyses
Courtney Ogilvy1, Rochelle Constantine2, Emma Carroll1
1University of Auckland, Auckland, Auckland, New Zealand, 2School of Biological Sciences, University of Auckland, Auckland, New Zealand, 1University of Auckland, Auckland, New Zealand
The Māui dolphin, *Cephalorhynchus hectori maui*, is endemic to the North Island of New Zealand and is one of the world’s rarest and most endangered marine dolphins. This sub-species is at risk of extinction and although conservation efforts were implemented in 2008, only 63 individuals are left in the remnant population along the North Island’s west coast. Prey abundance and distribution is assumed to be a major driver of the distribution patterns in small cetaceans who have high energy requirements and live in cold water environments. However, the only information on the Māui dolphin diet comes from one study that found cod, sole and flounder in the stomach contents of two beachcast animals. This research aims to increase our understanding of Māui dolphin diet in the context of their wider ecosystem, addressing fundamental knowledge gaps in Māui dolphin foraging ecology, the role of prey availability in species distribution, and the potential impact of existing conservation measures on diet. Here we use δ¹³C and δ¹⁵N stable isotope analysis of Māui dolphin skin samples collected between 1993 and 2021 (*n*=133) and potential prey samples (*n*=7 species; 5-10 samples each) to examine long-term dietary preferences. We compare isotope signatures of Māui dolphins across 20 years (1993 - 2008: *n*=13, 2010/11: *n*=30, 2015/16: *n*=30, 2020/21: *n*=30) to test for differences in diet over time, including before and after the establishment of a marine protected area in 2008. Each sample is associated with a genetic profile, permitting the effect of sex and relatedness on foraging to be assessed. Information on diet is essential for informing conservation management decisions and providing the best chance of ensuring long-term species survival. The existence of the Māui dolphin has reached a critical point, and the success of future conservation measures is crucial to prevent this endemic species from extinction.

**Satellite Telemetry Reveals Long-Distance Southward Movements and Deep Diving in Autumn by High-Arctic Ringed Seals**

Wesley Ogloff¹, Steven Ferguson², Aaron Fisk³, Marianne Marcoux², Nigel Hussey², Andrew Jaworenko³, David Yurkowski⁶

¹Winnipeg, ²Fisheries and Oceans Canada, Winnipeg, Manitoba, ³University of Windsor, Windsor, ON, ⁴University of Windsor, ⁵Pond Inlet, Nunavut, ⁶Fisheries and Oceans Canada - Freshwater Institute, Winnipeg, MB

Animal movements facilitate the transfer of energy and nutrients within and across regions, which in turn influences the structure and functioning of ecosystems. Understanding animal movements is thus a critical component of effective conservation and management. The movements of ringed seals (*Pusa hispida*), an Arctic-endemic species with a circumpolar distribution, are well-documented in a few locations: the western Canadian Arctic, Alaska, Hudson Bay, and Svalbard, but similar observations are lacking in the high Arctic. We equipped 12 ringed seals with satellite telemetry tags in Resolute Bay, NU (*n*=7; 2012, 2013), and Tremblay Sound, NU (*n*=5; 2017, 2018), to investigate their movements and diving behaviour from late summer until their moult the following spring. Six seal tags provided locations into the winter, capturing unexpected long-distance southward movements to southeastern Baffin Island. Three of these seals took routes along the coast of Baffin Island (3674 ± 655 km; maximum 4872 km), with one making, to our knowledge, the longest-recorded unidirectional movement by an adult male ringed seal (~2200 km). The other three travelled through the open water of Baffin Bay (3608 ± 315 km; maximum 4226 km), generally making shallower dives (25.4 ± 1.1 m; maximum 374 m) than the seals that travelled along the Baffin Island coast (100.0 ± 4.1 m; maximum 558 m). These movements from the high Arctic to the low Arctic suggest that ringed seals in the eastern Canadian Arctic might be more far-ranging than previously...
realized, potentially allowing for mixing between high-Arctic and low-Arctic ringed seal populations. Overall, our results suggest that ringed seals are highly variable in the paths and scales of their movements, as well as in their diving behaviour. This information can be used to inform spatial conservation and management for this ecologically and culturally important species.

Satellite tracking surveys on humpback whales around Okinawa (Ryukyu) Island, Japan.
Haruna Okabe¹, Sachie Ozawa², Nozomi Kobayashi³
¹Okinawa Churashima Research Center, Okinawa Churashima Foundation, Okinawa, Japan, ²Okinawa Churashima Research Center, Okinawa Churashima Foundation, Motobu, Okinawa, Japan

Humpback whales in the North Pacific migrate to their lower-latitude breeding grounds including Okinawa in winter. In this study, we conducted satellite-tagging surveys on humpback whales to clarify their local movements in Okinawan waters. Surveys were conducted in the 10-25 km offshore western area of Okinawa Island between February and March, 2018-2019. Wildlife Computers’ LIMPET satellite tags (SPLASH10, SPOT240) were deployed to 5 male whales. Among those 5 whales, 3 whales were tracked for 2-6 days after the deployments, while no data was transmitted for the other 2 cases. Out of 3 tracked whales, the first tagged whale moved 20 km northeast from the deployment site within a day, and then the transmission was stopped. The second whale was tracked for 5 days and moved northward along the coasts of several islands (Ihaya, Yoron and Okinoerabu) which are located 50-100 km away from Okinawa Island. The third whale was tracked for 6 days. The whale confirmed moving northwestward toward Ihaya Island, which is located about 40 km north of the deployment site, and started moving eastward to the northern area of Okinawa Island. Then, it went back to the coast of Ihaya Island again. 3 tagged animals were re-sighted 1-12 days after the tag deployments, and confirmed that the tags had already been dropped off. Photographs of the tag attachment sites on their bodies showed only small scars. One whale was re-sighted 2 years after tagging with no visible scars. In this study, all the whales confirmed moving northward. The results possibly indicate their northward migration toward the feeding grounds since tagging were conducted after late February, reaching the end of their breeding season. Obtaining more data with satellite tagging surveys during whole breeding season in this area is crucial for clarifying the local movement of this species in Okinawa.

Listening for solutions to false killer whale bycatch: Investigating acoustic cues leading to depredation in the Hawaii-based tuna-target longline fishery
Erin Oleson¹, Anne Simonis², Selene Fregosi¹, Colby Brady¹, Jamie Marchetti¹, Eric Kingma³
¹NOAA NMFS Pacific Islands Fisheries Science Center, Honolulu, Hawaii, ²NOAA National Marine Fisheries, San Francisco, California, ³Cooperative Institute for Marine Resources Studies, NOAA Pacific Marine Environmental Laboratory and Oregon State University, Hatfield Marine Science Center, ⁴NOAA NMFS Pacific Islands Regional Office, Honolulu, HI, ⁵NOAA NMFS Pacific Islands Region Observer Program, Honolulu, HI, ⁶Hawaii Longline Association, Honolulu, HI

Bycatch of, and removal of catch and bait from lines (depredation) by false killer whales (FKW) are significant management concerns in Pacific longline tuna fisheries including the Hawaii-based longline fleet. Most FKW bycatch events are associated with depredation, such that reducing depredation could reduce both overall bycatch rates and financial losses to fishermen from lost catch or damaged gear. The Pacific
Islands Fisheries Science Center has been collaborating with longline fishermen and the NMFS Observer Program for several years to deploy passive acoustic monitors to assess the rate and mechanism of interactions between the whales and the fishery. The timing of FKW sounds indicates the whales primarily occur when the gear is being hauled, and the whales generally move away from the vessel during the haul. Examination of the acoustic record for 58 trips across 40 different vessels has revealed the occurrence of a consistent noise generated by the boat or fishing gear that, when present, occurs during the first few hours of the 8-12 hour haul. The noise has been detected during 11 trips and on up to 5 of 7 monitored sets per trip. Fishing sets with this noise have depredation rates twice as high as those without. Based on input from fishermen on the potential source of the noise, a new program has now launched pairing in-air acoustic recordings on the deck of the vessel during fishing operations with the underwater recordings to identify the source of the sound and inform strategies to reduce or eliminate it. Acoustic cues, acting as a dinner bell, have been implicated in attracting whales to fishing gear in many fisheries. Eliminating the dinner-bell may not eliminate bycatch, but making it harder for whales to find gear will result in better outcomes for the whales and the fishermen.

Effects of whale-watching exposure on sperm whale foraging and near-surface behaviour

Cláudia Oliveira¹, Sergi Pérez-Jorge², Rui Prieto³, Irma Cascão⁴, Monica Silva⁵

¹IMAR – Institute of Marine Research, Horta, Portugal, ²Okeanos R&D Centre, Institute of Marine Research, University of the Azores, Horta (Faial) - Azores, Portugal, ³Portugal, ⁴MARE – Marine and Environmental Sciences Centre; IMAR Centre at the University of the Azores, Horta, Portugal, ⁵Institute of Marine Research (IMAR) and Okeanos R & D centre, University of the Azores, and Marine and Environmental Sciences Centre (MARE), Horta, Azores, Portugal, ⁶IMAR - Institute of Marine Research & Okeanos Center - University of the Azores, Horta, Portugal

Short-term responses of cetaceans to disturbance might negatively affect individual fitness. These negative impacts are more severe for those individuals that are frequently exposed to disturbance, as the repeated interactions can lead to long-term unbalance of their energy budget. Here we instrumented 26 sperm whales with digital acoustic recording tags (DTAGs) to investigate the effect of whale-watching on the vital activities of the species. Based on the collected data, foraging and near-surface behaviour proxies were compared between control and whale-watching exposure treatments using linear mixed effect models. During near-surface non-vertical resting periods, sperm whales performed a higher number of shallow dives, showing an apparent evasive behaviour, when exposed to whale-watching vessels. In foraging dives, sperm whales increased vertical velocity during descent and ascent phases compared to periods without whale-watching vessels. In addition, sperm whales’ dives were about 100 m shallower, with longer bottom phases, after whale-watching exposure periods. Nevertheless, no changes were found in the number and duration of buzzes (indicative of prey capture attempts) between the two treatments. These results suggest that the presence of whale-watching vessels modify sperm whale near-surface behaviour and alter their transit movements during foraging dives, which may affect their energy preservation and expenditure, respectively. On the other hand, we cannot confirm neither dismiss an effect on energy intake, since our method cannot test if prey composition was affected by the different dive depths. This work contributes to a better understanding of how anthropogenic disturbance may affect marine mammals and is relevant for the sustainability of the growing whale-watching industry.
The role of collagen in blubber expandability in grey seals
Laura Oller1, Mark Dagleish2, Joel Rocha1, Louise Nicoll3, Ailsa Hall4, Kimberley Bennett4
1Abertay University, Dundee, United Kingdom, 2Moredun Research Institute, Edinburgh, United Kingdom, 3Abertay University, 4Sea Mammal Research Unit, St. Andrews, United Kingdom

Collagen content increases with adipocyte size and it is associated with comorbidities in humans. However, seals undergo large fat depot fluctuations during their life cycle without suffering apparent metabolic complications. We investigated if grey seal collagen content and gene expression increase with fat deposition and vary across blubber depth. Biopsy samples from mother were collected at early lactation. Samples were processed for histology and gene expression analysis. Human gluteo-femoral fat histology blocks (n = 4) were collected from Edinburgh biobank for comparison. Collagen content in adult female seals was not significantly different from humans (t-test: p=0.739), despite seals having bigger adipocytes (t-test: p<0.001). This suggests adipocytes have less structural support in blubber than in human fat. However, grey seal blubber showed a clear collagen fibre orientation (Angle from a cross-section plane: 80.9° ± 29.1 SD) that was not present in human gluteo-femoral fat. Seal blubber collagen orientation may allow rapid expansion and contraction of blubber, which could help avoid metabolic complications despite fluctuations in blubber thickness.

Stereotyped disjunct whistle types produced by Atlantic white-sided dolphins, Lagenorhynchus acutus
Ciara Olmstead1, Kathryn Rose2, Laela Sayigh3
1Mount Holyoke College, South Hadley, Massachusetts, 2International Fund for Animal Welfare, 3Woods Hole Oceanographic Institution/Hampshire College, Woods Hole, Massachusetts

Acoustic recordings of Atlantic white-sided dolphins (Lagenorhynchus acutus) in Wellfleet, Massachusetts, USA were examined to learn about whistle types produced by this relatively unstudied species. Our dataset contained one day (08/10/2014), during which the species producing whistles was visually confirmed as L. acutus. On this day, we found a variety of stereotyped, disjunct whistle types, where the frequency contour would end and then simultaneously pick up at a different frequency. We focused on visually identifiable whistle types that occurred at least 2 times; 18.7 minutes of whistles were produced and placed into 113 distinct types, each type produced 2 to 179 times (average=12). Individual whistle types had anywhere from 2 to 9 disjunct components, and the frequency gaps ranged from 49.5 to 8883 Hz. We identified an additional 376 disjunct whistle types in 88.7 minutes of recordings from multiple days for which we did not have visual confirmation of the species, but which were presumed to be L. acutus. Each was produced from 2 to 182 times (mean = 13), with 1-9 disjunct segments. Across all recordings, the mean interval between whistles of the same type was 6.56 sec (with 30 sec being the maximum interval included for this analysis), suggesting that these whistles may function as signature whistles, given the similarity in bout structure to bottlenose dolphin signature whistles. To our knowledge, stereotyped whistles with these characteristics are unlike any described for other dolphin species. Our findings could have implications for using whistle detections in density estimations of L. acutus, as a single whistle may consist of as many as 9 discrete components. Overall, these results add new insights into the diversity of delphinid communicative signals.
Mapping Reveals High Degree of Overlap Between Vessel Traffic and the Occurrence of Two Dolphin Species in Maui Nui, Hawai‘i
Grace Olson1, Stephanie Stack2, Abigail Machernis1, Florence Sullivan2, Jens Currie2
1Pacific Whale Foundation, Wailuku, HI, 2Pacific Whale Foundation

The increase and diversification of vessel traffic worldwide have resulted in varying forms of known disturbances to cetaceans. As a remote island chain, the Hawaiian islands rely heavily on the marine environment for transportation, recreation, and fishing; resulting in high vessel traffic. Given the known presence of odontocetes in this region, there is a gap in knowledge regarding the extent of exposure risk vessel traffic presents to island-associated dolphin populations. This research identified the spatial use areas of pantropical spotted dolphins (Stenella attenuata) and common bottlenose dolphins (Tursiops truncatus) and the extent of their overlap with the density of various vessel categories in Maui Nui, Hawai‘i. Species distribution was determined using kernel density estimates based on sighting data from 53 spotted dolphin encounters and 79 bottlenose dolphin encounters collected on systematic boat-based surveys covering 38,962 km from 2013-2018. A combination of GPS and Automatic Identification Systems (AIS) vessel tracks were used to quantify vessel traffic within the study area, resulting in 22,464 vessel tracks used for analysis. Both species were exposed to vessel traffic throughout 100% of their range, but the extent and intensity of the risk varied spatially. The highest risk from vessel overlap for spotted dolphins occurred in offshore deeper waters while the highest risk for bottlenose dolphins was in shallow, coastal waters. The majority of overlap was from commercial transportation and tourism vessel traffic; covering more than 80% of each species’ distribution. This work highlights the differences in levels of vessel exposure risk to dolphins based on species and vessel category and serves as a baseline to guide management actions aimed to minimize vessel disturbance to these highly vulnerable island-based dolphin populations.

Alpha shape analyses reveal patterns of 3D vaginal complexity in marine mammals
Dara Orbach1, Charlotte Brassey2, James Gardiner3, Patricia Brennan4
1Texas A&M University- Corpus Christi, Corpus Christi, Texas, 2School of Science and the Environment, Manchester Metropolitan University, Manchester, UK, Manchester, United Kingdom, 3Department of Musculoskeletal and Ageing Science, Institute of Lifecourse and Medical Sciences, University of Liverpool, Liverpool, United Kingdom, 4Mount Holyoke College, South Hadley, MA

Shape analyses provide a way to quantify diversity in anatomical structures and discern potential evolutionary patterns. Shape analyses are often limited to structures with homologous landmarks, which frequently precludes soft tissue. We use alpha shape complexity scores of digitized silicone vaginal endocasts to overcome quantification hindrances and to assess 3D vaginal diversity in 40 marine mammal specimens. We then explored potential evolutionary drivers of vaginal shape complexity. Extensive intraspecific variation was documented. Cetaceans had a wide range of vaginal complexity scores while pinnipeds had comparatively simple vaginas. The sirenian vaginal shape was surprisingly complex. Phylogenetic signal was weak and the data did not support the hypotheses that natural selection (relative neonate size) nor sexual selection (relative testes size, sexual size dimorphism, and penis morphology) drive vaginal complexity. Alternative metrics, such as penile shape complexity, may explain patterns of marine mammal vaginal shape and the importance of genital coevolution. Our novel
application of 3D surface heat maps revealed that complexity was achieved by regionalized protrusions and invaginations of the tissue, and enables identification of specific parts of the vagina under selection pressure. The utility of using alpha shape analyses to discern the complexity of 3D anatomical structures lacking homologous landmarks is widespread.

Relating marine mammal distribution to prey fields derived from echosounding

Chris Orphanides¹, Michael Jech², Jeremy Collie³, Debra Palka⁴
¹NOAA Fisheries, Narragansett, RI, ²NOAA Fisheries, ³University of Rhode Island Graduate School of Oceanography, ⁴NMFS/NEFSC, Woods Hole, MA

Managing human impacts on marine mammal populations depends on understanding their distributions in space and time. Knowledge of these distributions is becoming increasingly important due to offshore energy development and climate induced shifts in oceanic habitat. Most models assessing pelagic marine mammal abundance and distribution primarily use ocean surface or bottom variables as proxies for water-column habitat. Here we use a ship-based marine mammal sighting survey to test the utility of echosounder-based predictive variables for modelling marine mammal distribution and abundance. We assessed the distribution of seven marine mammal species along the shelf break south of New England relative to the spatial structure of organism groups derived from acoustic data with an established algorithm. We used this algorithm to classify detected prey into four categories: 1) fish with swim bladders, 2) larval fish and zooplankton, 3) fluid-like zooplankton, and 4) fish with no swim bladder. Acoustic backscatter was quantified using the area backscattering coefficient along the survey track line within bins 1000 m in length and either 50 or 200 m in depth. We then built Generalized Additive Models (GAMs) using only these acoustically derived variables to explain marine mammal distribution. The resulting GAMs explained between 1% and 37% of deviance, with model fit reflecting feeding depth and prey preference. This work demonstrates the potential of echosounding to model marine mammal distribution and abundance using direct measurements of prey rather than proxies. Additional analysis is underway to expand this analysis to include additional survey years.

Abundance and spatial distribution of sperm whales (Physeter macrocephalus), dwarf/pygmy sperm whales (Kogia spp.) and beaked whales (Ziphiidae) in the northern Gulf of Mexico

Joel Ortega-Ortiz¹, Lance Garrison², Jenny Litz³, Gina Rappucci⁴, Laura Aichinger Dias⁵, Anthony Martinez⁶, Melissa Soldevilla⁶, Keith Mullin⁷
¹University of Miami, Cooperative Institute for Marine & Atmospheric Studies, Miami, Florida, ²Miami, FL, ³Marine Mammal and Turtle Division, SEFSC, NOAA Fisheries, Miami, Florida, ⁴Cooperative Institute for Marine and Atmospheric Studies, University of Miami, Hallandale, Florida, ⁵CIMAS/UM, NOAA/SEFSC, Miami, Florida, ⁶Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL, ⁷NOAA Fisheries Southeast Fisheries Science Center, Pascagoula, MS

The Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) was implemented to quantify abundance and spatial distribution of marine mammals in the Northern Gulf of Mexico (GoMx). Three line-transect vessel surveys were conducted during the summers of 2017 and 2018 and winter 2018 covering waters from the 100m isobath to the U.S. economic exclusive zone. Mark-recapture Distance Sampling utilizing an independent observer approach was used to estimate detection probability within the surveyed area and estimate detection probability on the trackline, and
external data on dive-surface behaviors were used to account for availability at the surface. These recent data were combined with survey data from 2003-2009 to develop spatially explicit density models. Physiographic and environmental variables from remote sensing sources and hydrodynamic models were integrated with survey data within a generalized additive modeling framework to develop habitat-based density models for sperm whales (*Physeter macrocephalus*), dwarf/pygmy sperm whales (*Kogia* spp.) and beaked whales (Ziphiidae). Physiographic features of the GoMx were important predictors of the density of each group with sperm whales more closely associated with the shelf-break, beaked whales showing a bimodal density distribution with both shelf-break and deep water peaks in density, and *Kogia* spp. occurring primarily in deeper waters of the outer slope. The loop current and mesoscale eddies were also important predictors of density with higher densities for all three taxa associated with lower geostrophic velocities occurring at the confluence between eddies. We discuss seasonal and interannual changes in spatial distribution of these taxa as a function of variability in underlying physical oceanographic features. Predictive maps of animal density are an important tool for management agencies tasked with assessing and mitigating the impacts of human activities on marine mammals as required under the U.S. Marine Mammal Protection Act and Endangered Species Act.

The Conservation and Management Plan for Aquatic Mammals (cetaceans, manatees and otters) of the Magdalena Department, Colombian Caribbean

Ingrid Ortiz Parra¹, Guiomar Aminta Jauregui Romero¹, Ingrid Ortiz Parra¹

¹Sea Turtles and Marine Mammals Conservation Program, Colombia

Aquatic mammals are a very diverse group that has 42 species in the marine and continental territory of the Caribbean and Pacific Colombian. In the last 10 years the study and conservation actions have been increased, through the specific efforts of NGOs, universities, Regional Autonomous Corporations and the Ministry of Environment and Sustainable Development, for this reason and through an inter-institutional agreement between the Tayrona Project of Petrobras, Ecopetrol, Repsol, Statoil, as part of its social responsibility guideline, together with the Magdalena Autonomous Regional Corporation-CORPAMAG, the Omacha Foundation, the Museo del Mar Foundation with its Sea Turtles and Marine Mammals Conservation Program-ProCTMM and the FOSPIINA S.A.S. Aquarium and Sea Museum, the Conservation and Management Plan for Aquatic Mammals (cetaceans, manatees and otters) of the Magdalena Department was structured, compiling secondary information both empirical as a technique for registering these species, diagnosing threats and prioritizing lines of action and programs for their conservation. The Magdalena region in its marine ecosystems, rivers and wetlands, has 17 species of aquatic mammals grouped into 15 species of cetaceans, 1 of sirenian and 1 of mustelid. This rich diversity corresponds to 77.2% of the 22 confirmed species for the Colombian Caribbean. Among the most representative species of cetaceans are the Atlantic spotted dolphin (*Stenella frontalis*) and the delfín hocico de botella (*Tursiops truncatus*) para la estación seca y el delfín gris (*Sotalia guianensis*) para la estación lluviosa. Los reportes sobre el manatí *Trichechus manatus* y la nutria neotropical *Lontra longicaudis* son escasos y se limitan a registros de observaciones directas y rastros de comederos.

Saving Gomez: The Last Great American Whale

John Ososky, Smithsonian Institution, Suitland, Maryland

In January of 2019 a whale presumed to be a
Gulf of Mexico Bryde’s whale stranded in Everglades National Park. A multi-agency response ensued which included NOAA’s Southeast Fishery Science Center and the Florida Fish and Wildlife Conservation Commission. An agreement was made to save the entire skeleton of the whale for use as a possible holotype of a new species and the specimen was buried in a sandpit in Fort Desoto State Park near St. Petersburg. This talk chronicles the journey of the specimen from stranding to burial and exhumation at Fort Desoto and then on to the Bonehenge Whale Center, Beaufort NC, where it was further cleaned, and finally to the National Museum of Natural History where the specimen was finished and installed in the collection. This specimen is now designated as the holotype of a new species (Rice’s whale, *Balaenoptera ricei*). I will present evidence from the skeleton of a past ship strike—an important manmade hazard affecting this now critically endangered species. Finally, I connect the collection of this specimen with the history of whale conservation at the Smithsonian.

A novel integration of methods to evaluate cohesion and synchrony in delphinid movement

Machiel Oudejans¹, Fleur Visser², Brandon Southall³, Holly Fearnbach⁴, Sam Leander⁵, Selene Fregosi⁶, Caroline Casey⁷, John Durban⁸

¹Dulra Research, Heiloo, Netherlands, ²Kelp Marine Research, Hoorn, ³Southall Environmental Associates, Inc., Apts, California, ⁴SR3, SeaLife Response, Rehabilitation and Research, Seattle, WA, ⁵Southall Environmental Associates, San Diego, CA, ⁶Cooperative Institute for Marine Resources Studies, NOAA Pacific Marine Environmental Laboratory and Oregon State University, Hatfield Marine Science Center, ⁷UC Santa Cruz, Santa Cruz, California, ⁸Oregon State University

While highly abundant in many areas across the globe, comparatively little is known about the behavioral ecology of the smaller Delphinoids, such as common dolphins (*Delphinus sp.*). This lack of knowledge extends to their sensitivity to disturbance, including to the many anthropogenic noise sources in their environment. This is largely due to their propensity to occur in ephemeral, often fast-moving and very large groups. Given the focus on individual-level research in cetacean ethology, most field and analytical methods do not apply to small delphinids, or fail to obtain behavioural data at the appropriate resolution or scale. Tracking individual delphinids, for example, using tags or observational techniques, is extremely challenging. Moreover, the gregarious and social nature of these species calls for observation at the level of the group. Using a newly developed suite of group-level observational and analytical methods to study behavior and responses to noise, we investigated cohesion and synchrony in *Delphinus* groups, observed off Santa Catalina Island (CA, USA). Grouping behaviour and synchrony were tracked at two resolutions. Lower, but full resolution group-level observations from shore-based platforms was combined with high resolution, partial-group observation from remotely-controlled octocopter drone photogrammetry that tracked the simultaneous movement of multiple animals. To test the hypothesis that movement is coordinated at the level of the group, we fitted hierarchical movement models to both levels of observations, and investigated temporal changes in common parameters that described cohesion and synchrony. The resulting data provide new information on the extent and scale of social coordination in large groups of dolphins, representing key context for understanding their behavioural responses and vulnerabilities to disturbance.
Does it help to be different? The effect of structural complexity on intra-individual variability of signature whistles in Indo-Pacific bottlenose dolphins (Tursiops aduncus).

Ekaterina Ovsyanikova¹, Barry McGovern², Rebecca Dunlop³, Michael Noad⁴
¹University of Queensland, Brisbane, Australia, ²Pacific Whale Foundation Australia, Hervey Bay, QLD, Australia, ³Cetacean Ecology and Acoustics Laboratories group, School of Veterinary Science, University of Queensland, Dunwich, QLD, Australia, ⁴Cetacean Ecology and Acoustics Laboratories group, School of Veterinary Science, University of Queensland, GAtton, Australia

Bottlenose dolphin (Tursiops spp.) signature whistles (SW) are stereotyped signals that contain identity information in their frequency modulation pattern. Considering the prevalence of SW in dolphins’ vocalizations, they likely contain additional information, which would require some level of variability within the signal. In this study we analyzed intra-individual variability of SW and measured its relatedness to the structural complexity of the whistles. We hypothesized that more complex whistles could vary more while maintaining identity features, potentially providing a social advantage to their owners. Data were collected from a group of provisioned wild Indo-Pacific bottlenose dolphins (T. aduncus) in Moreton Bay, Australia. This allowed repeated observations of the animals and definitive matching of SW to some individuals. Two scores were developed to quantify variability for each of the SW type. The first represented the average coefficient of frequency variation (CoV) of frequency, calculated at 20 equally spaced points along the whistle contour. The second score was the average CoV of basic whistle parameters (start, end, maximum and minimum frequencies, duration, number of inflections). To measure whistle structural complexity, we calculated four metrics: coefficient of modulation, average number of inflection points, autocorrelation, and Parson’s entropy. A generalised linear model was used to determine the effect of complexity on variability. Our results showed that whistles with greater coefficient of frequency modulation varied more than less modulated ones ($R^2 = 0.84$; $p < 0.001$). Additionally, contour variability appeared to be higher in males than in females, but our sample size was insufficient for quantitative analysis. These results suggest that bottlenose dolphin signature whistles can contain additional information expressed in the variability of their frequency contours, and that higher levels of whistle modulation may facilitate this variability while maintaining individual distinctiveness.

First observation and hunting behavior of a female humpback dolphin (Sousa plumbea) at the end of the Red Sea Gulf of Eilat IL

Goffman Oz, Haifa University IMMRAC, Haifa, Israel

Indian Humpback dolphins (Sousa plumbea) are found throughout the tropical, subtropical, central and western Indian Ocean - including the Red Sea, Persian Gulf, Suez Gulf and the Suez Canal. On January 4th 2021 we gathered the first evidence of Sousa plumbeas occurrence in the northern-most point of the Gulf of Eilat (Israel) & Aqaba (Jordan) - a female humpback dolphin (Sousa plumbea) with a calf that was still nursing. The pair arrived safely to the northern part of the Gulf of Eilat & Aqaba. In the first 10 days mother and calf spent their days & nights at the marina in Eilat, but the calf disappeared after this 10-day period, and has not been seen since – therefore, presumed dead. The adult female has been named “Ella”, she has remained in the area since, often in a small lagoon in the north shore of Eilat and has been monitored both visually and acoustically. “Ella” has been documented during 22 days within a three-month time frame along the north shore of Eilat from surveys aboard a 5-meter vessel. Observations have been recorded.
by means of a drone (DJI Mavic Mini 2 with 4K @30fps Resolution Camera) to study behavior and several telephoto DSLR cameras to confirm identification of this individual via Photo ID of the dorsal fin. “Ella” has been observed spending most of her time spent in the Eilat lagoon, often hunting. The images and videos recorded also provide evidence of the adult female *S. plumbea* displaying four kinds of fishing methods – during which four kinds of fish and invertebrates were captured including Fringelip mullet (*Crenimugil crenilabrus*), Red Sea houndfish (*Tylosurus choram*), Common cuttlefish (*Sepia officinalis*) and an unidentified species of shrimp.

**Sightings of cetaceans in the department of Magdalena, Colombia**

Ana Maria Pacheco Cardenas¹, Ingrid Ortiz Parra², Guiomar Aminta Jauregui Romero², Anthony Combatt¹, Ingrid Ortiz Parra²

¹Universidad Jorge Tadeo Lozano, Santa Marta, Colombia, ²Sea Turtles and Marine Mammals Conservation Program, Colombia

At the department of Magdalena, Colombia, it has been confirmed the presence of 15 species of cetaceans. The highest number of reports has been obtained between the Taganga Bay and the sector of Tayrona National Natural Park (PNNT), and between the Santa Marta Airport and the marine area of its own Bay. The most representative species, according to previous studies, are *Stenella frontalis*, *Tursiops truncatus* and *Sotalia guianensis*. This region offers favorable environmental conditions for its transit and incursions into the costal zone, exposing itself to threats such as fishing nets, that cause dolphin mortality, degradation of coral ecosystems, seagrass beds and mangroves that generate loss of their food supply. During the first quarter of 2021, observations have been made in the morning hours, from a catamaran-type boat, through the different bays of the region. Using binoculars, GPS, camera and a binnacle where departure and arrival times were recorded, along with observations of oceanographic conditions. In 18 tours carried out, 4 sightings of dolphins *T. truncatus* and *Steno bredanensis* have been reported, in groups of approximately 30 to 60 individuals, made up of adults, juveniles and youngs. On one occasion, the effort of a female *S. bredanensis* to reanimate her dead calf was evidenced. Among the group activities, stands out the displacements, food and some games with plastic bags that were seen in the area. The presence of these specimens is favored by the bathymetry and geomorphology of the region, with oceanic incidence, which is influenced by the time of upwelling and contributions from the rivers. They are gregarious species, a trait of sociability that appeared in their evolutionary history for better feeding, care of young and defense against predators.

**Age as a determinant factor of the microbial composition in wild harbor seals**

Arlette Pacheco-Sandoval¹, María Asunción Lago-Lestón², Yolanda Schramm³, María Elena Solana⁴, Alicia Abadia-Cardoso⁵

¹CICESE, Mexico, ²ENSENADA, BAJA CALIFORNIA, Mexico, ³Universidad Autónoma de Baja California, Ensenada, Baja California, Mexico, ⁴CICESE, ⁵Universidad Autónoma de Baja California

The composition of an individual's microbiota changes over time in response to different factors such as nutrition, age, and environment. Age-related microbial variations have been extensively studied in humans and model animals, showing that diet differences primarily drive them. However, these variations are poorly understood in wildlife, and the information available is scarce. The distinct short lactation phase in phocids provides an exceptional opportunity to explore the microbiota's response to a rapid transition from a milk-based to a solid diet. In this study, we investigated the effect of
age and sex on the gut microbiota of 32 Mexican harbor seals (*Phoca vitulina richardii*) using a 16S rRNA amplicon sequencing approach. We found that age explains most of the observed differences in microbial composition, and sex-related differences between ages were discernible when the abundance of microorganisms was evaluated. We identified more microbiological similarities between individuals who had frequent contact (female adults and pups) than those with little or no contact (male adults and pups). Overall, adults and females (regardless of their sex and age, respectively) have a greater diversity of microbes, and as seals grow, the core microbiome shrinks while microbial diversity increases.

Our results also indicate that pups were transitioning into a solid diet supported by the presence of degradation pathways for milk and chitin compounds. Also, an enrichment of routes related to dramatic weight loss and body mass indicates higher metabolic stress in pups during the late breeding season, when they are weaned and start fasting. Our findings highlight the host-microbiome interaction in harbor seals in response to feeding regime alterations and metabolic stress at the end of the breeding season.

Protected Species Observer Data: Approaches to Stop Discounting It for What It Cannot Do and Start Using It for What It Can

Aude Pacini1, Sarah Courbis2, Craig Reiser3, Mari A. Smultea4, David Steckler5, Julio Rivera6
1Hawaii Institute of Marine Biology, Kane'ohe, Hawaii, 2Advisian Worley Group, Portland, Oregon, 3Smultea Environmental Sciences, Anchorage, 4SES-Smultea Environmental Sciences LLC, Preston, Washington, 5Mysticetus, Redmond, Oregon, 6Arizona State University, Tempe, AZ

When permits are issued for activities that could affect marine mammals, many countries require that third-party protected species observers implement mitigation. Traditionally, data obtained during observation has been difficult to analyze in the context of species distribution, density, and abundance, but there are other ways this untapped resource around the world can inform science and conservation. For example, offshore wind siting and development on the US East Coast has created a platform to examine ways to improve data collection, consistency, and sharing and consider approaches to improve and optimize the value of observer data. New technologies for collecting, QA/QCing, managing, querying, and publishing these data, are providing new opportunities. Discounting these data dismisses fine-scale information from thousands of hours of surveys and activities (e.g. based on monitoring we conducted during site surveys, the 21 proposed US East Coast wind projects will result in approximately 354,000 hours of monitoring and 52,000 detections of approximately 385,000 individual marine mammals). It is important to refocus energy on the questions this growing plethora of data may be able to address and not on the questions they cannot. While these data may not be adequate for density estimates, they can provide information like heat maps of fine-scale habitat use, ground truthing of models, increased understand of rare species, and inputs to PCoD frameworks. The growing interest in offshore renewables globally affords an opportunity to address data gaps in poorly surveyed regions. Bias in observations must be considered, but statistical approaches to this have been successfully applied to “citizen science.” Conservation and management of marine mammals would benefit by better use of these data, and we will elaborate on how this can be done via consistent metrics, modelling and assessment frameworks, and data integration and sharing to bridge geographical gaps, increase industry transparency, and support stewardship.
Sexy Hump-back? Progesterone concentrations in female humpback whales (Megaptera novaeangliae) predict their attractiveness in the Hawaiian breeding grounds

Adam Pack¹, Shannon Atkinson DeMaster², Kendall Mashburn³
¹University of Hawaii at Hilo, Hilo, Hawaii, ²University of Alaska Fairbanks, ³University of Alaska Fairbanks, Juneau, AK

North Pacific female humpback whales have been studied in Hawaiian waters, their principal calving and mating grounds, since the 1970s. Yet little has been done linking behavior with a fundamental physiological characteristic governing reproduction, progesterone concentrations. We examined whether a) blubber progesterone concentrations vary seasonally, b) reproductive potential, which tends to be greater in non-lactating mature females, is reflected in progesterone concentration, and c) females with greater progesterone concentrations attract greater numbers of male escorts. Biopsy samples along with behavioral data were collected in 2004-2006 and 2016 off west Maui. Progesterone concentration was measured in 67 females including 30 lactating females (Mean=9.87 ng/g, SE=2.81; Median=6.10 ng/g, IQR=7.49) and 37 non-lactating (non-calf, non-yearling) females (Mean=12.61 ng/g SE=3.45, Median=1.79 ng/g, IQR=15.71). Across all females, there was a significant increase in progesterone concentrations over breeding season months (Kruskal-Wallis (3) =12.08, p=0.007), a trend that overlaps with peak numbers of humpbacks and peak male-male aggression. There was no significant difference in progesterone concentrations between lactating females overall and non-lactating females in competitive groups (i.e. those comprised of a single mature female and two or more males) (Mann-Whitney U, Z = -0.944, p=0.345). However, females in competitive groups with 3 or more males had greater progesterone concentrations than females in groups with less males (Kruskal-Wallis (3) =11.27, p = 0.01). Overall, these findings enhance our understanding of the humpback whale mating system by showing that a) when progesterone concentrations are elevated, reflecting ovulation (and possible conception), females have maximum choice among fertile males, b) lactating and non-lactating mature females may experience similarly elevated progesterone concentrations prompting some males, perhaps who are ill-equipped physically to successfully compete for the latter females, to prospect among the former for potential mating opportunities, and c) females who are likely ovulating, with greater progesterone concentrations, attract more males.

Feeding habits changes of Zalophus wollebaeki linked to effects of El Niño-Southern Oscillation in the Galapagos Archipelago

Diego Paez-Rosas¹, Xchel Moreno-Sánchez¹, Arturo Tripp-Valdez¹, Sara Carranco-Narváez¹, Fernando R. Elorriaga-Verplancken²
¹Universidad San Francisco de Quito, San Cristobal, Galapagos, Ecuador, ²La Paz, Baja California Sur, Mexico

The Galapagos sea lion, Zalophus wollebaeki (GSL) has undergone a drastic population decline over the last four decades, due to constant feeding stress caused by oceanographic anomalies like El Niño-Southern Oscillation (ENSO) events. To assess the impact of the strong 2015-2016 ENSO on GSLs, their diet diversity, trophic niche breadth, and trophic level (TL) from 2014 to 2016, were evaluated through scat analysis. The overall trophic spectrum comprised 71 fish species, the most important prey items (IIMP) were O. berlangai (11.51%), V. lucetia (8.82%), and Symphurus spp. (8.17%). There were no significant interannual differences (F=2.15, p=0.104) in the abundance of prey from different habitats; however, GSLs consumed a greater abundance (47%) of benthic prey in 2015.
The PERMANOVA analysis detected interannual dietary differences ($F=11.9, p=0.001$) and the NMDS test indicated that, although a considerable part of the diet was similar, 2015 stood out. The GSL can be classified as a specialist consumer ($Bi=0.21$), with the lowest value in 2015 ($Bi=0.06$). The overall TL was 4.6, indicating a secondary-tertiary consumer. The presence of prey from different habitats (benthic, epipelagic, reef, and mesopelagic) suggests a diversification strategy to reduce resource overlap between individuals. This top predator exhibited trophic flexibility during ENSO events, evidenced by a rapid response to anomalous environmental conditions that included reducing the trophic niche and an increase in the consumption of prey from greater depths. These results highlight the importance of this species as a bio-indicator for environmental changes around Galapagos archipelago, a unique ecosystem that is a marginal habitat for this endangered species.

**Respiratory Pathology in Stranded Cetaceans of the Southeastern Florida Coast**

Annie Page-Karjian¹, Wendy Marks², David Rotstein³, Sushan Han⁴, Eliana De Luca⁵, Greg O’Corry-Crowe⁶

¹Florida Atlantic University, Fort Pierce, FL, ²FAU Harbor Branch Oceanographic Institute, ³Marine Mammal Pathology Services, Olney, Maryland, ⁴Colorado State University, ⁵University of Georgia, ⁶Florida Atlantic University

Stranded cetaceans commonly present with pneumonia and other respiratory tract lesions. Gross and microscopic pathological data were reviewed from the archives of Florida Atlantic University’s Harbor Branch Oceanographic Institute Marine Mammal Stranding and Population Assessment Program to identify odontocete cases with respiratory pathology that stranded along the southeastern coast of Florida during 2013–2020. Of 32 cases, 25 (78%) had respiratory lesions, including 10 Atlantic bottlenose dolphins (*Tursiops truncatus*), six pygmy sperm whales (*Kogia breviceps*), three melon-headed whales (*Peponocephala electra*), two Atlantic spotted dolphins (*Stenella attenuata*), one dwarf sperm whale (*Kogia sima*), one Gervais’ beaked whale (*Mesoplodon europaeus*), one Blainville’s beaked whale (*Mesoplodon densirostris*), and one sperm whale (*Physeter macrocephalus*). Pulmonary edema was the most common respiratory abnormality (N=20), followed by pneumonia (N=14), pulmonary hemorrhage (N=11), granulomatous inflammation (N=8), congestion (N=6), emphysema (N=3), pleural fibrosis (adhesions) N=2, and interstitial fibroplasia (N=2). Ten cases had pulmonary lymphadenopathy, six cases had verminous pneumonia characterized by infestation with nematodes (N=4) and trematodes (N=2), and two cases had mixed bacterial and fungal pneumonia. Frozen respiratory tissue samples from these cases were tested for Morbillivirus, Influenza, Parainfluenza, Coronavirus, and *Mycoplasma* spp. using PCR. Lung tissue from one bottlenose dolphin tested positive for Cetacean Morbillivirus (100% sequence identity), *Mycoplasma* spp., and Parainfluenza. Lung tissue from another bottlenose dolphin and a Gervais’ beaked whale tested positive for *Mycoplasma* spp. All samples tested negative for Influenza and Coronavirus. Verminous pneumonia in free-ranging cetaceans may be associated with immune suppression from other factors such as contaminant exposure, while pulmonary congestion and edema are often associated with drowning, shock, and cardiopulmonary arrest. *Mycoplasma* spp. has been isolated from the lungs of cetaceans that stranded with pneumonia in Europe, but this is the first report of its isolation in lung samples from cetaceans that stranded in North America.
Habitat use and distribution of franciscana dolphins in Babitonga Bay, southern Brazil: a passive acoustic monitoring approach
Renan Paitach1, Guilherme Bortolotto2, Mats Amundin3, Marta Cremer4
1Federal University of Santa Catarina, Brazil, 2University of St Andrews, St Andrews, Fife, United Kingdom, 3Kolmården Djurpark, Kolmården, Sweden, 4University of the Joinville Region, São Francisco do Sul, Santa Catarina, Brazil

The closed population of franciscana dolphins in Babitonga Bay is threatened by several human activities. Understanding their habitat use and distribution in different spatio-temporal scales is essential for adequate management and mitigation of impacts. Using data from sixty passive acoustic monitoring stations (i.e., C-PODs), implemented in the bay between June and December 2018, the relationship between the occurrence of dolphins and several environmental covariates was investigated with generalized additive models. The final model presented 51% of explained deviance and identified important covariates related to habitat use of animals, with the time of day, maximum slope, bottom sediment and the presence of sympatric Guyana dolphins among them. A daily distribution pattern was identified, with franciscanas remaining in the areas of greatest occurrence, especially in early hours. Areas intensively used by Guyana dolphin are avoided. Franciscanas also seem to avoid steeper areas and prefer areas with sandy bottoms. For mapping their distribution, Empirical Bayesian Kriging was employed using “Detection Positive Hours (DPH) per day” and “Feeding Buzz Ratio (weighted by DPH)” separately to, respectively, identify the main areas of occurrence and to identify important feeding areas, at different periods of the day (dawn=00:00-05:59, morning=06:00-11:59, afternoon=12:00-17:59, night=08:00-23:59) in each sampled season. Franciscana dolphins are consistently predominant in the innermost region of the estuary, without expressive use of the entrance channel, with a wider area used in the winter than in spring. The entire central region of the islands, between the north and south banks, represents an important area for foraging, which occurs most often during the dawn and night. This study provides important insights into habitat use and distribution of this critically endangered population. Habitat modeling allowed the identification of their critical habitats and thereby is a strong tool to guide the main management requirements necessary for their conservation.

Orca Orcinus orca (Linneaus 1758) and false killer whales Pseudorca crassidens (Owen 1846) in Osa, Puntarenas, Costa Rica: behavior, temporal and spatial distribution
Jose David Palacios-Alfaro1, Monica Gamboa Poveda2, Jose Damian Martinez Fernandez3, Ana Lucia Rodriguez-Tinoco4, Cristina Sanchez-Godinez5
1Independent reseacher, San Jose, Costa Rica, 2Costa Rica Por Siempre, San Jose, Costa Rica, 3FECOP, Costa Rica, 4Destination Photo, Escazu, San Jose, Costa Rica, 5MARVIVA, San Jose, San Jose, Costa Rica

In the South Pacific of Costa Rica, 16 species of cetaceans have been reported, however, for many of them the information is scarce and collected in a short period of time. To record the presence of Pseudorca crassidens and Orcinus orca data was collected from whale watching trips departed from Uvita and Drake Bay in Osa, as well as reports from tour guides and captains for a period of 14 years, from 2005-2018. A total of 11 cetacean species were registered in the area, and specifically for false killer whales and orcas a total of 261 records were made. The false killer whales were observed more frequently, with 252 sightings distributed during all months. The habitat used by the groups was coastal waters and open waters, and important aggregations were recorded in areas around Isla del Caño Biological Reserve, Marino Ballena and Corcovado.
National Parks and Terraba-Sierpe. The most common observed behavior were travelling and feeding. At least 11 fishes species were predated. Also sexual behavior was observed for this species. The orca was less frequent observed, with 9 sightings, and was registered in five months (dry and rainy season). They prefer open water with some sightings in coastal areas. In some cases, they prey on humpbacks whales, sharks and fishes. In conclusion, *P. crassidens* is a common visitor in Osa, while *O. orca* is reported as occasional. The area of Osa showed to be very important for false killer whales for feeding purposes.

Can You Hear Me Now? The COVID-19 Lockdown as a Natural Experiment into the Effects of Vessel Noise on Bottlenose Dolphin Communication
Laura Palmer1, Paul M. Thompson2, Virginia Iorio-Merlo2, Nathan Merchant1, Stephanie King4
1University of Bristol, Bristol, County, United Kingdom, 2University of Aberdeen, Cromarty, United Kingdom, 3Cefas, Lowestoft, United Kingdom, 4University of Bristol, Bristol, United Kingdom

The interruption of socio-economic activity during the COVID-19 lockdown provided an unintentional natural experiment into how human behaviour impacts various aspects of the natural world. Anthropogenic noise in the marine environment has increased dramatically in recent decades, with consequences for vocal communication in cetaceans. Several studies have shown that increases in vessel traffic can affect the source level, duration and/or frequency parameters of dolphin whistles, but it is unclear from these studies whether the changes in whistle parameters were driven by shifts within individual whistle types, or switches to different whistle types in the whistle repertoire. In the Moray Firth, Scotland, COVID-19 lockdown measures led to reduced vessel traffic for a period of several months, providing a rare opportunity to assess dolphin vocal plasticity in the context of a sustained reduction in vessel presence. We used passive acoustic data collected from two sites in the Moray Firth in 2018 and during the COVID-19 pandemic in 2020 to assess the effect of noise on the whistle characteristics of bottlenose dolphins. We quantified whistle signal-to-noise ratio and categorised whistle types using an automated adaptive resonance theory neural network with dynamic time warping (ARTWARP). We compared the frequency content and duration of individual whistle types (i) between years and, (ii) between sites, where vessel traffic was differentially affected by the lockdown measures. We found a significant effect of noise on whistle type duration between sites (*p* < 0.0001) and other effects on frequency parameters. We discuss what our findings tell us about adaptability and vocal plasticity in this species.

Evaluation of the effectiveness of CABOW, a real-time mitigation tool for monitoring exclusion zones associated with offshore construction
Kaitlin Palmer1, Paul King1, Douglas Gillespie2, Sam Tabbutt3, Jesse Turner1, Jessica Thompson1, Dominic Tollit5, Jason Wood4
1SMRU Consulting, Vancouver, BC, 2University of St Andrews, St Andrews, Fife, United Kingdom, 3SMRU Consulting, 4SMRU Consulting, Friday Harbor, WA, 5SMRU Consulting North America

Offshore wind development is slated for the east coast of the united states. The technology has the potential to decrease reliance on carbon fuels. However, the areas slated for development overlap with north Atlantic right whale (Eubalanea glacialis) habitat. Sounds associated with construction have the potential to disturb or harm animals up to several kilometers of the activity. As part of monitoring and mitigation efforts we have developed real-time technology to monitor the presence of acoustically active
right whales within a 160 dB isopleth exclusion zone. The Coastal Acoustic Buoy for Offshore Wind (CABOW) is a bespoke, bottom-mounted, real-time acoustic monitoring buoy that uses a neural network (Shiu et al., 2020) to detect NARW upcalls and three hydrophones to estimate bearings to calling animals. CABOW buoys are designed to be placed around construction exclusion zones in order to maximize conservation outputs while limiting costly shutdowns for the renewables industry. Here we present the effectiveness of the system as determined by playback trials as well as a case study targeting another critically endangered, local species, southern resident killer whales. For the effectiveness results we present detection function of the system as determined by playback studies (maximum detection radius > 5km), bearing error as a function of signal to noise ratio (6±23° between 20 and 40 dB SNR). As part of the local case study, we also monitor the presence and bearing of southern resident killer whales around Point Roberts, WA, USA using the PAMGuard whistle and moan detector. These results show the potential benefit of integrating multiple data sources, e.g. classification and bearing, into real-time conservation applications.

Life history of New Zealand common dolphins (Delphinus delphis)

Emily Palmer1, Sinead Murphy2, Emma Betty3, Matthew Perrott4, Karen Stockin5

1Massey University, New Zealand, 2Galway-Mayo Institute of Technology, Galway, Ireland, 3Massey University & Auckland University of Technology, Auckland, Auckland, New Zealand, 4Massey University, 5Massey University, Auckland, New Zealand

There is a lack of basic life history knowledge on the New Zealand common dolphin (Delphinus delphis). Critical parameters of reproductive biology were assessed from carcasses collected from stranding events and incidental bycatch in the jack mackerel (Trachurus novaezelandiae) trawl fishery between 1997 and 2020. A total of 104 and 185 females, and 64 and 164 males, were examined for reproduction and growth, respectively. Age was estimated from decalcified thin sectioned teeth, and gross and histological examination of testis and ovarian samples was conducted. Males ranged in total body length from 89 to 244 cm and females from 82 to 233 cm, with maximum ages of 26 and 29 years obtained for males and females, respectively. Using a double-Gompertz growth model, physical maturity was obtained for males at ~216 cm and at 15 years of age. A Richards growth model was used for females and asymptotic length was obtained at 201.6 cm and at 12 years of age. The average age and length at attainment of sexual maturity was 183.5 cm and at 7.5 years for females. For males, sexual maturity was obtained at 198.4 cm and at 8.76 years. A pregnancy rate of 30% and a calving interval of 3.2 years were determined. Length at birth was estimated at 87.6 cm. These reproductive parameters concur with North Hemisphere populations that are in decline from fisheries bycatch. Anthropogenic impacts, including fisheries bycatch, are well documented for the New Zealand population as well as wider (genetically connected) Australasian common dolphins. It is hypothesised that density dependent factors have affected the life history of the New Zealand common dolphin.

Mediterranean Monk Seal Monitoring in the Central Ionian Sea, Greece - 35 Years of Studies

Aliki Panou1, Luigi Bundone2, Panagis Aravantinos3, Tulio Kokkolis3

1Archipelagos, Environment and Development, Athens, Greece, 2Archipelagos - ambiente e sviluppo, Italia, Venice, Italy, Italy, 3Soularoi-Kefalonia, Greece

The Mediterranean monk seal sub-population inhabiting the central Ionian Sea, Greece (Kefalonia, Ithaca, and the nearby islets) was
systematically monitored between 1985 and 2002. Dedicated surveys focused on the use of haul-out habitats (marine caves) and on recording of seal sightings. Out of 140 potential terrestrial habitats, 16 were regularly used by seals and in 5 of them pupping was documented. 1-4 pups were recorded annually and up to 3 seals were found together in the same cave. Best estimates of the seal numbers based on careful evaluation of available data revealed a minimum of 15-20 individuals in the area (all age classes). These findings were confirmed in subsequent studies. In 2018, we installed infrared cameras in 16 caves strategically covering the entire central Ionian: 11 caves known to have been frequently used by seals in the past plus 5 additional caves. In only 2 out of the 16 caves no evidence of seal use was recorded but this may be circumstantial since monk seals do change their cave preferences with time. In 4 of the known pupping caves were used for pupping again along with a fifth cave used for reproduction for the first time. Identification of individuals was based on photographic capture-recapture data. We used strict criteria to define each animal record including morphological age classes and gender. At present, 20 individuals are fully identified. Animals not fully identified yet, juveniles and pups are not included here. In 2020, we recorded 9 pups and up to 7 seals were found together in the same cave. Movements of animals between distant caves of up to ca. 45 n.m. were repeatedly recorded. This actively reproducing population is crucial for the conservation and recovery of the species, particularly with respect to the Adriatic-Ionian region.

Epigenetic biomarkers for xenobiotic exposure and environmental stress in Mediterranean fin whales

Cristina Panti¹, Annalaura Mancia², Matteo Baini¹, Giacomo Limonta¹, Andrea Maria Ferri¹, Luigi Abelli³, Fossi Maria Cristina³

¹University of Siena, Siena, Siena, Italy, ²University of Ferrara, Ferrara, Italy, ³University of Ferrara, Ferrara, Italy

Mediterranean cetaceans are increasingly exposed to a plethora of anthropogenic impacts, including the pressure exerted by chemicals pollutants. Among the different effects, as a result of the exposure to environmental pollutants, epigenetic modifications, such as DNA methylation (DNAm), can occur and subsequently affect and regulate gene expression. A panel of hyper- and hypo-methylated genes have been identified after the analysis of DNAm profiling through reduced representation bisulfite sequencing (RRBS) in a previous study carried out on fin whale (Balaenoptera physalus) skin biopsies with different contaminant loads. The organisms were sampled in the Specially Protected Area of Mediterranean Interest Pelagos Sanctuary (North – Western Mediterranean Sea), which is one of the most polluted area of the Mediterranean Sea. A selection of hyper- and hypo methylated genes mainly involved in cell differentiation and functioning of vascular and nervous systems (hypo-methylated genes: CCDC93, SETD1A, SMARCA2, PKP3; hyper-methylated genes: OTX1, PCBP3, CLSTN1, SHANK1, GRAMD4) was further investigated and quantified in 2 fin whale skin biopsies collected in the Pelagos Sanctuary in spring-summer 2018-19.

The variation in the expression of the selected genes quantified by droplet digital PCR (ddPCR) indicated a correlation to individual’s blubber contaminant load (plastic additives such as phthalates) suggesting the potential role of environmental stressors on DNAm and, in turn, on silencing/activation of transcription. These results provide a first insight on the potential use of a panel of biomarker genes related to epigenetic modifications, which can be used as prognostic markers for genetic adaptation of a vulnerable species to a changing environment in such contaminated environment as the Mediterranean Sea.
Utilizing human-centered design to build an open-source marine soundscape data hub with which to better inform marine mammal ecology and policy

Anmol Parande1, Yueyi Che1, Leena Elzeiny1, Saisindhu Goli1, Edgar Hildebrandt Rojo1, Justin Hogenauer2, Sara Kopunova2, Audrey Kuptz2, Choyang Ponsar2, Anne Simonis3

1Berkeley, 2University of California, Berkeley, Berkeley, CA, 3NOAA National Marine Fisheries, San Francisco, California

The biological, anthropogenic, and geologic sounds that make up a soundscape can inform the conservation and management of protected species and habitats. The biological components of soundscapes can be useful to characterize biodiversity and monitor the distribution and behavior of individual species. Anthropogenic sound in the ocean is increasing and has been recognized as a threat to marine mammals for decades. In order to understand the impacts of this ocean noise, it is imperative to establish baseline conditions of natural soundscapes, understand how changing soundscapes impact species, and quantify those changes to the soundscapes. As such, marine resource managers require current, comprehensible information to make well-informed decisions. However, despite their wide use in terrestrial ecosystems, soundscape assessments are still a relatively new tool for marine ecosystem management. Based on a series of interviews we conducted with researchers, policymakers, and environmental lobbyists, we decided to portray spectral soundscape metrics alongside the context of animal and human activities in a map format. We then created a digital hub for marine soundscape information that researchers, policymakers, and the public can use to easily understand, analyze, and synthesize marine-sourced soundscape data. Our hub is an open-source website displaying spatial and temporal soundscape data, acoustic detections of marine mammals, and mapped species habitats. The platform not only displays ocean soundscape data, but also relevant research, news, and baselines on the map. This new product will facilitate ecosystem-scale conservation policy by helping researchers and policymakers access and understand soundscape data. Our website will help to better guide conservation efforts in complex ocean ecosystems experiencing intense soundscape transformations.

Employing drones to assess compliance with the guidelines for responsible observation of bottlenose dolphins (Tursiops truncatus) in the Sian Ka’an Biosphere Reserve, Mexico

Leslie Mariel Paredes Torres1, Nataly Castelblanco-Martínez2, Eric Angel Ramos3, Carlos Alberto Niño-Torres4, Luis Medrano González5, Natalia Garces C6, Nataly Morales Rincon7

1Universidad Nacional Autonoma de Mexico, Mexico, 2Consejo Nacional de Ciencia y Tecnologia, Universidad de Quintana Roo, Departamento de Ciencias e Ingenieria, Chetumal, Quintana Roo, Mexico, 3The Graduate Center, City University of New York, BROOKLYN, NY, 4University of Quintana Roo, Chetumal, Quintana Roo, Mexico, 5Universidad Nacional Autónoma de México, Mexico, 6University of Quintana Roo, 7Universidad Veracruzana

In 2018, basic guidelines for responsible bottlenose dolphin watching tourism within the Sian Ka'an Biosphere Reserve (SKBR) were proposed and implemented by the Mexican government after conversations with local authorities and primary stakeholders. Our goal was to evaluate tour boat compliance with these dolphin watching guidelines. From September to November 2021, we conducted boat-based surveys and flew a small quadcopter drone (DJI Mavic 2 Pro) to film tour boat interactions with bottlenose dolphins, each time a vessel or group
of vessels arrived in the area to observe the same group of dolphins was considered a Tourist Watching Event (TWE). The drone videos and data collected from boat were analyzed, to evaluate if each TWE were in compliance with the main guidelines: 1) Observation time, less than 10 minutes; 2) Distance to dolphins, less than 30 m; 3) Number of vessels at the observation area, less than three; 4) Arrival and departure of the vessels at low speed (10 km/h) and without invading areas for dolphins’ movement. We invested 40 hrs. of observation and documented 253 TWE, of which 82 were recorded in drone videos. Ninety eight percent of the tourist events did not comply at different levels with the items mentioned, and only 2% fully complied with the regulations. “Distance” was the least respected item, 96% of the TWE occurred less than 30 m of the dolphins, the mean permanence time watching a group of dolphins was 13.6 minutes (max=43 min, min=2 min, \( N=253 \)), and the mean number of vessels observing simultaneously was 4 (max=13, min=1, \( N=142 \)). These results show the urgency of promoting the use of responsible dolphin observation guidelines through workshops and ongoing educational programs, prioritizing the welfare of the animals to ensure economic benefits to the community.

**Underwater Soundscapes of the Endangered Hawaiian Monk Seal**

**Kirby Parnell**1, Karlina Merkens2, Aude Pacini3, Lars Bejder4

1University of Hawaii at Manoa, 2NOAA/PIFSC, 3Hawaii Institute of Marine Biology, Kane’ohe, Hawaii, 4Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, Hawaii, HI

Describing underwater soundscapes of critical habitats of marine mammals can provide valuable information on the acoustic environment utilized by these sound-reliant animals. For the endangered Hawaiian monk seal (Neomonachus schauinslandi), whose underwater hearing abilities and vocal communication were recently described, soundscapes of their aquatic habitats are poorly understood. We measured ambient noise levels and identified the acoustic signals that contribute to the underwater soundscape at four critical habitats of the Hawaiian monk seal: Rabbit Island and Lehua Rock in the Main Hawaiian Islands, and French Frigate Shoals and Pearl and Hermes Reef in the Northwestern Hawaiian Islands. We recorded underwater sounds continuously with SoundTrap 500HF acoustic recorders at sites with varying habitat types for a total of 179 days. We measured broadband (20-24000 Hz) and octave-band (center frequencies of 31.5, 250, 500, and 16000 Hz) sound pressure levels (SPLs) in hourly intervals across the entire recording period at each site. Average hourly broadband SPLs ranged from 107.8-123.4 dB re 1 \( \mu \text{Pa} \). Investigation of octave-band SPLs confirmed diel patterns associated with biological sources at all sites and anthropogenic sources at one site. We opportunistically recorded two large-scale geophysical events: Hurricane Douglas (Category 4) and a 6.2 magnitude earthquake increased the 31.5 Hz octave-band SPL. Biological sound sources including fish, invertebrates, and marine mammals shaped the soundscape at all sites. This study provides the first description of underwater soundscapes at critical habitats of the Hawaiian monk seal across its expansive range. These measurements can be compared to future sound levels to understand the impact of human activity on underwater soundscapes.

**Impacts of Tropical Cyclones on the Underwater Soundscape in the Northern Gulf of Mexico**

**Dawn Parry**1, Holger Klinck2, Dimitri Ponirakis3

1K. Lisa Yang Center for Conservation Bioacoustics, Cornell Lab of Ornithology, Department of Natural Resources and the Environment, Cornell University, Ithaca, New
The northern Gulf of Mexico (GoMex) is one of the most industrialized marine areas in the United States due to ongoing largescale exploration and extraction of fossil fuels and high levels of commercial shipping activity. The nearly continuous presence of anthropogenic acoustic signals makes it difficult to assess natural ambient sound levels at low frequencies below 1 kHz. Funded by the U.S. Department of the Interior, Bureau of Ocean Energy Management, Cornell University operated an array of passive acoustic recorders to assess ocean ambient sound levels in the area between May 2018 and June 2021. During the deployment period, several tropical storms and hurricanes moved through the study site. The highest tropical cyclone activity was registered for the 2020 Atlantic hurricane season, which was the most active and the fifth costliest Atlantic hurricane season on record. These tropical cyclones provided us with a unique opportunity to study low-frequency ambient sound levels in the complete absence of anthropogenic signals. For brief periods that typically lasted 2-3 days, seismic exploration and shipping came to a complete halt because of hazardous weather conditions (high sea states). Initial analysis efforts focused on tropical storm Barry that moved over our array between 11 and 15 July 2019. The closest point of approach (CPA) between tropical storm Barry and the array hydrophones varied between 0.8 km and 74.1 km, respectively. The impacts on the ambient sound levels were remarkable. During the CPA, hourly $L_{eq}$ levels in the 1/3 octave band with the center frequency of 63.1 Hz dropped by up to 40 dB re. 1 $\mu$Pa$^2$. Those levels immediately jumped back to pre-Barry levels after the cyclone made landfall in Louisiana, and vessels could be safely operated again. These atmospheric events may provide critical information on baseline low-frequency sound levels relevant for future soundscape management strategies.

In the wake of small cetaceans: Can targeted eDNA sampling support stock structure analysis for small or elusive cetaceans?

Kim Parsons (she/her)$^1$, Sam May$^1$, Zachary Gold$^1$, Kimberly Goetz$^2$, Alexandre Zerbini$^3$, Christine Gabriele$^4$, Jan Straley$^5$, John Moran$^6$, Marilyn Dahlheim$^7$, Linda Park$^7$, Phillip Morin (he/him)$^8$

$^1$Northwest Fisheries Science Center, NOAA Fisheries, Seattle, WA, SEATTLE, wa, $^2$NOAA-AFSC-MML, Seattle, WA, $^3$Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA, ‘Glacier Bay National Park, Gustavus, AK, $^4$University of Alaska, Sitka, Alaska, United States Minor Outlying Islands, $^6$NOAA Fisheries/Alaska Fisheries Science Center, Juneau, AK, $^7$Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA Fisheries, Seattle, WA, $^8$Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, La Jolla, CA

Genetic data are important for defining populations and supporting the conservation and management of marine mammals. Despite proven methods for collecting genetic samples from cetaceans, some species are particularly elusive and traditional methods are ineffective, leaving critical gaps in population assessments. This is particularly true for harbor porpoise (Phocoena phocoena), the smallest cetacean in the North Pacific. Harbor porpoises are distributed throughout shallow coastal waters, making them vulnerable to incidental fisheries bycatch and nearshore habitat degradation. Concern for localized bycatch impacts on harbor porpoise stocks in Alaska motivated population genetic analyses using archived tissue samples collected opportunistically from carcasses (n = 85). Using nuclear single nucleotide polymorphisms (SNPs) and mitochondrial DNA (mtDNA) sequences, we examined the population genetic structure of harbor porpoise
Alaska using a hierarchical approach to evaluate evidence for genetic differentiation among *a priori* geographic strata. Targeted environmental DNA (eDNA) sampling was used to supplement genetic samples in key geographic regions where numbers of tissue samples were prohibitively small or nonexistent. Surface seawater eDNA samples (n = 78) were collected in porpoise fluke prints from small boats. Exploiting naturally shed cellular debris and the power of next generation sequencing, we amplified and sequenced harbor porpoise control region sequences from marine eDNA samples. These data were incorporated as geo-referenced haplotype frequencies into analyses of molecular variance (AMOVA) to quantify genetic diversity among harbor porpoise in the coastal waters of Southeast Alaska. Combining the power of genetic data generated from both tissue and eDNA samples, we revealed patterns of population structure indicating natal fidelity and limited dispersal among coastal regions, suggesting the presence of population boundaries within currently recognized stocks. These genetic data provide a valuable contribution to new lines of evidence for evaluating stock boundaries in support of management practices for this nearshore cetacean.

An updated range-wide assessment of *Neophocaena*: threats and priorities for research and conservation

**Tishma Patel¹, John Y. Wang², Denise Greig³, Ellen Hines⁴**

¹San Francisco State University, ²CetAsia Research Group / Trent University, Thornhill, Ontario, ³California Academy of Sciences, San Francisco, California, ⁴Tiburon, CA

The genus *Neophocaena* encompasses two species of finless porpoises inhabiting coastal waters (<50m) from the Persian Gulf through Southeast Asia, China, Korea, and Japan. The Indo-Pacific Finless Porpoise (*N. phocaenoides*) and the Narrow-Ridged Finless Porpoise (*N. asiaeorientalis*). Within *N. asiaeorientalis* there are two subspecies, the Yangtze Finless Porpoise (*N. a. asieroientalis*), found in freshwaters in China and the East Asian Finless Porpoise (*N. a. sunameri*), found in coastal marine waters of China, Korea, Japan, and Taiwan. All population trends are considered to be decreasing and the Yangtze Finless Porpoise population critically endangered by the International Union for Conservation of Nature (IUCN) Red List. Habitat degradation, pollution, and anthropogenic activities are a few known threats affecting populations, with bycatch as one of the worst threats. At the 2019 World Marine Mammal Conference in Barcelona, Spain, a workshop was held presenting research on finless porpoise populations. Participants agreed that a major issue impeding conservation for *Neophocaena* *spp.* in most areas is the lack of basic information about their distribution, abundance, and population structure. This lack of knowledge and these critical threats showcase a need for range-wide research that contributes to conservation planning. Scientists discussed research, management, and conservation efforts regarding known finless porpoise populations and agreed research on population distribution, habitat and ecology, fisheries related mortality, and alternative solutions to mitigate bycatch needs to be prioritized. Participants also recommended standardizing research protocols and approaching conservation and management creatively with public and educational outreach programs. This presentation will summarize the discussions from the workshop and compile known information on habitat, threats, current research, and recommendations made by region and overall.

Population Structure and Social Alliances of the Burrunan Dolphin (*Tursiops australis*) in Gippsland Lakes, Australia

**Marinda Pattison¹, Jeff Shimeta², Kate Robb³**

¹Marine Mammal Foundation, ²RMIT University, Melbourne, Victoria, Australia, ³Marine Mammal Foundation, Mentone, Victoria, Australia
Sociality in the animal kingdom has been observed in taxa from primates to cetaceans, and can be directly related to the individuals' and population's fitness. Cetaceans are highly intelligent, long-lived predators with particularly complex social lives. This project investigated the social system of the endemic, endangered Gippsland Lakes population of Burrunan dolphins, with the overreaching aim of defining their population structure and investigating the presence, variation, and drivers of any social alliances. From 2014 – 2019 a total of 261 sightings were recorded across 149 boat-based surveys days conducted by the Marine Mammal Foundation. Using the unique nicks and notches on the dolphins dorsal fin 131 individual marked dolphins were catalogued. Group sized varied among seasons as an influx of transients entered the system each winter. Social and temporal analysis on 81 regularly sighted individuals found one socially well differentiated population within the sample, 43% displayed high fission-fusion dynamics, with 57% forming a highly cohesive, gender-based structure with complex and dynamic alliances, including non-random and long-term preferred associations. Males formed few strong, long-lasting alliances, while females formed more, moderate, less stable alliances, both strategies thought to ultimately enhance reproductive success and maximise fitness. Longer-term assessments and social analyses along with genetic exploration of kinship relationships are recommended to gain a deeper understanding of the social structure.

Understanding the impacts of vessel traffic on whale behavior is a crucial aspect of cetacean conservation. The Sounders are a small group of gray whales (*Eschrichtius robustus*) that stop to feed in North Puget Sound during their annual migration. This leg of their journey exposes them to several boat-based whale-watching operations, as well as recreational and commercial vessel traffic. Research on other cetacean species has indicated that watercraft presence may have adverse effects, such as disrupted foraging, increased energy expenditure, and avoidance of heavily trafficked areas. There are limited studies about the impacts of boat presence on the behavior of gray whales. To evaluate this question, land-based research is being conducted using a theodolite to track the location and movement of gray whales and vessels within 1 km. Tracking and observations are being recorded from four sites around Hat Island, Washington. This data will be used to determine if boat activity affects mean dive times, direction and deviation indices, average swimming speeds, and changes in surface behaviors of gray whales. The proportion of time gray whales are spending with and without boats present within 1 km will also be assessed. These observations began March 14th and ended May 14th, 2021. To date, whales have been tracked for approximately 51 days for a total of 76.5 hours. These efforts have resulted in 36.0 hours of which vessels were present within 1 km of whales, which occurred in 47% of all observations of whales. The Sounders’ prolonged periods of foraging close to shore provide an ideal opportunity to study the impacts of boats on gray whales, the results of which may better inform the conservation and regulation of the species.

**Do boat activities affect the behavior of Sounders in inland waters? A study on gray whales (*Eschrichtius robustus*) in North Puget Sound.**

Alexander Pavlinovic¹, Kiirsten Flynn², John Kirkpatrick³, John Calambokidis⁴

¹The Evergreen State College, ²Cascadia Research Collective, Olympia, Washington, ³Evergreen State College, ⁴Cascadia Research Collective, Olympia

**Longitudinal study of entanglement scars on humpback whales (*Megaptera novaeangliae*) off the coast of central California**

Allison Payne¹, Ellen Hines², John Calambokidis¹, Jennifer Tackaberry⁴, Tim M
Markowitz5, Wim Kimmerer6
1San Francisco State University, Golden Gate Cetacean Research, Dana Point, California, 2Tiburon, CA, 3Cascadia Research Collective, Olympia, 4Cascadia Research Collective; Center for Coastal Studies, Pacific Grove, CA, 5The Marine Mammal Center, 6San Francisco State University

The waters off the central coast of California are an important seasonal feeding ground for endangered and threatened populations of humpback whales. Although their numbers have increased since the end of industrial whaling in 1971, humpback whales nonetheless face challenges to recovery, with entanglement in fishing gear cited as a primary threat for California populations. Since 2014, there has been a sharp increase in reported entanglements along the US West Coast, particularly off of central California. The increase in reports has triggered repeated closures for local commercial fisheries. As only a small percentage of entanglements are reported, it can be difficult to ascertain whether increased reports are due to increased entanglements or better reporting. Scar-based studies conducted on individually identified humpback whales are a key method for examining changes in the yearly rate of entanglements based on acquisition of entanglement scars. The resulting yearly entanglement rate is relevant for resource managers who need to assess the effectiveness of important management actions, such as the closure of the commercial Dungeness crab fishery. We used photographs and data collected by Cascadia Research and collaborators for 106 individually identified humpback whales which had been sighted off central California for 7 or more years between 2004-2018. Photographs of the caudal peduncle and fluke insertions from these encounters were analyzed for new or existing entanglement scars, such as gear wrapping scars or notches. We found elevated yearly entanglement rates after 2013 compared to pre-2013 levels, coinciding with the increase in reported entanglements. This timing also coincided with habitat compression caused by a marine heatwave that forced greater spatiotemporal overlap between whales and fisheries. These results provide an important metric for managers to track the number of entanglements that typically go unreported and identify a metric for evaluating the effectiveness of implemented anti-entanglement measures.

Conservation genetics of the inshore Bryde’s whale (Balaenoptera edeni brydei) off South Africa
Dominique Paynee1, Els Vermeulen2, Gwenith Penry3, Paulette Bloomer4
1University of Pretoria, Johannesburg, Gauteng, South Africa, 2Mammal Research Institute Whale Unit, University of Pretoria, South Africa, Hermanus, Western Cape, South Africa, 4Institute for Coastal and Marine Research, Nelson Mandela University, Port Elizabeth, South Africa, 5Molecular Ecology and Evolutionary Programme, Department of Biochemistry, Genetics and Microbiology, University of Pretoria, South Africa

Bryde’s Whales (Balaenoptera edeni brydei) are an elusive species, therefore information on many aspects of their ecology is limited and difficult to obtain. Along the South African coastline, a resident inshore population occurs year-round. This population is small (<1000 individuals) and evidence of population structure within its limited distributional range is lacking, but photo-identification data suggest that there may be separation. By using neutral genetic markers such as microsatellites, the potential genetic structure within the inshore population can be revealed. This study will assess the level of differentiation in the population by analysing 83 Bryde’s whale samples collected in this study and previously. Samples from various locations on the east and west coasts of South Africa will be used to detect possible spatial population structure. The results of this study will provide a
better understanding of the distribution of the inshore Bryde’s whales along the South African coastline and aid in implementation of effective conservation strategies for this vulnerable population. If spatial structure is detected, then subpopulations may need to be managed separately in conservation planning. This is of particular importance due to the high number of fatal entanglements in coastal fishing gear, and ongoing competition for small pelagic fish species of economic importance. Delineation of subpopulations in an already small, endemic population of large whales would be critically important to include in an ecosystem approach.

Spatial variation in trophic interactions of bottlenose dolphins (Tursiops truncatus) within the Florida Coastal Everglades assessed with stable isotopes
Valeria Paz¹, Michael Heithaus², Jeremy Kiszka³
¹Florida International University, ²Florida International University, North Miami, ³Florida International University, North Miami, Florida

Bottlenose dolphins (Tursiops truncatus) are an upper trophic level predator of the Florida Coastal Everglades (FCE), which is comprised of multiple habitats including creeks, rivers, shallow inland bays that feature numerous mangrove islands, and the coastal oceans of the Gulf of Mexico and Florida Bay. As an abundant predator throughout the FCE, bottlenose dolphins could play important roles in the ecosystem through both top-down and bottom-up pathways. To date, however, little is known about trophic interactions of dolphins in the FCE and how they might vary within and among habitats. Bulk stable carbon ($\delta^{13}$C) and nitrogen ($\delta^{15}$N) isotope analysis of skin and blubber biopsy samples (n=90) were used to investigate trophic interactions of dolphins across four major habitats of the FCE. These habitats, including mesohaline rivers (n=13), an inland low-salinity bay (n=5), a coastal oligohaline bay (n=37), and marine waters of Florida Bay (n=18), and the Gulf of Mexico (n=16), have food webs that are isotopically distinct. Values of $\delta^{15}$N suggest that dolphins feed at a similar trophic level system-wide. Unlike other top predators studied in the FCE (e.g., bull sharks, American alligators), however, $\delta^{13}$C values suggest that bottlenose dolphins appear to restrict their foraging within the habitats where they were sampled. Estimated age for each sampled individual using DNA methylation methods suggest that trophic interactions did not vary significantly with age. Our results suggest that bottlenose dolphins likely form multiple discrete foraging communities across the FCE but may play different ecological roles across these foraging locations.

Development of thermoregulatory control during ontogeny of Weddell seals (Leptonychotes weddellii)
Linnea Pearson¹, Lars Tomanek², Heather Liwanag³
¹California Polytechnic State University, ²California Polytechnic State University, San Luis Obispo, CA, ³California Polytechnic State University, San Luis Obispo, California

Heat balance can be difficult for young marine mammals in polar regions, because harsh environmental conditions combined with small body size, insulation type, and physiological immaturity can increase heat loss. We used infrared imaging to measure surface temperature ($T_s$) of Weddell seal pups (n=18) at 4 age timepoints throughout dependency (1w, 3w, 5w, 7w) under varying ambient temperatures ($T_a$). While all pups were the same calendar age at the time of the measurements, there was wide individual variation in molt status, mass, and blubber depth. Pups with full lanugo or just starting to molt maintained the same thermal gradient ($T_s-T_a$) regardless of $T_a$, and the lowest $T_s-T_a$ of all pups (15.3±9.77°C and 13.4±11.2°C, respectively), suggesting lanugo is a very efficient insulator across the range of ambient
temperatures measured in this study (-20.7–1.7°C). For molting pups (mix of lanugo and juvenile pelage), $T_s-T_a$ increased as $T_a$ decreased, suggesting they maintain $T_s$ to promote molting, despite the increased gradient and heat loss at colder temperatures. This is in contrast to fully molted pups (no lanugo, full juvenile pelage), where $T_s-T_a$ decreased as $T_a$ decreased, suggesting they have full vasococontrol of their skin and are able to modulate heat flux across a range of temperatures to prevent heat loss in colder ambient conditions. Heat transfer models indicate that radiation contributed 61.4±0.17% of total heat loss, while convection and conduction accounted for the remaining 33.3±17.9% and 6.4±0.03%, respectively. There is likely an energetic advantage to molting quickly and when ambient conditions are warmer. Though lanugo is a very effective insulator in air, previous studies have shown pups with lanugo and molting pups have higher resting metabolic rates in water than molted pups. Thus, despite the increased heat loss in air, molting is an important step in the transition to an aquatic lifestyle.

Humpback Whales (Megaptera novaeangliae) and Tourism in Juneau, AK: Establishing Baseline Measurements during the COVID-19 Pandemic

Heidi Pearson¹, Shannon Atkinson DeMaster², Valentina Melica³, John Moran⁴, Suzie Teerlink⁵
¹University of Alaska Southeast, Juneau, Alaska, ²University of Alaska Fairbanks, ³University of Alaska Fairbanks, College of Fisheries and Ocean Sciences, Juneau, AK, ⁴NOAA Fisheries/Alaska Fisheries Science Center, Juneau, AK, ⁵NOAA Fisheries, Juneau, Alaska

During 2020-21, the cancellation of cruise ships and reduction in tourism due to the COVID-19 pandemic afforded us an unprecedented opportunity to study humpback whales (Megaptera novaeangliae) in Juneau, AK. Juneau’s cruise ship-driven whale-watching industry is among the world’s largest, supporting 68 tour vessels catering to >360,000 passengers and generating nearly $60 million in economic revenue in 2019. The steady pre-pandemic growth of this industry has led to concerns about potential impacts of whale-watching vessels on whales. Previous studies have revealed changes in humpback whale behavior (speed, direction change, respiration rate) in the presence vs. absence of whale-watching vessels that may indicate an avoidance response; however, the physiological drivers or consequences of these behavioral changes are unknown. We aimed to collect baseline data on humpback whales during a time of reduced vessel traffic by: 1) assessing residency patterns via photo-identification and 2) measuring stress hormone biomarkers via skin/blubber biopsy sampling while controlling for reproductive status. Data were collected during May-November 2020-21. Seventy-one skin/blubber biopsy samples were collected from 34 individuals; 16 individuals were biopsied in both years and 13 individuals were re-biopsied >30 d later in the same year. One-hundred-three non-calf individuals were photo-identified; 27 were photo-identified in both years. Across both years, mean residency was 42.4±53.40 SD. Controlling for effort, residency did not vary between years; however, females exhibited longer residency than males and individuals of unknown sex (both p<0.001). Considering the influence of temporal and reproductive factors, cortisol levels were higher in 2020 (vs. 2021, p<0.01) and in May (vs. October, p<0.05); these factors did not significantly affect corticosterone levels. This work is continuing in 2022 as tourism levels rebound, providing a natural experiment for studying humpback whales under varied tourism. We will share our findings with managers and stakeholders to ensure sustainability of Juneau’s whale-watching

Anna Pearson¹, Todd Schmitt², Todd Robeck³, Luis A. Hückstädt⁴, Michael Tift⁵

¹University of North Carolina Wilmington, ²SeaWorld San Diego, San Diego, CA, ³SeaWorld and Busch Gardens Reproductive Research Center, San Diego, CA, ⁴Institute of Marine Sciences, University of California Santa Cruz, Santa Cruz, California, United Kingdom, ⁵University of North Carolina, Wilmington, Wilmington, North Carolina

Certain deep-diving seals (e.g., elephant and Weddell seals) are known to have levels of carbon monoxide (CO) in their blood that are similar to those seen in chronic cigarette smokers (>10% carboxyhemoglobin; COHb). The source of high CO in certain seals is currently unknown. The gas is naturally produced in humans and lab animals as a byproduct of heme degradation, by heme oxygenase enzymes. Therefore, CO production is tightly correlated with red blood cell (RBC) lifespan and associated Hb degradation, as shown by higher COHb (average 1.9%, maximum 9.7%) in patients with shortened RBC lifespans due to hemolytic anemia. Although normally considered a toxic gas, low levels of CO are naturally produced in most mammals (≤1% COHb in healthy humans), and exposure to moderate concentrations of exogenous CO has shown to elicit cytoprotective effects (e.g., anti-inflammation) in tissues exposed to hypoxia or ischemia-reperfusion events. Therefore, there is a desire to ascertain the mechanisms behind the regulation of elevated CO in marine mammals. Similar to humans, the production of high concentrations of CO in marine mammals is hypothesized to be directly related to their RBC lifespan. The RBC lifespan has been determined in a variety of terrestrial vertebrates, but never reported for any marine mammal species. In terrestrial mammals, there is an allometric relationship with larger animals having longer RBC lifespans (RBC lifespan (days) = body mass (kg)^0.132 (68)). This study reports the first measurements of RBC lifespan in a marine mammal, the shallow-diving bottlenose dolphin (mass = 216 ± 23 kg, Hb = 14 g/dl). Our results show the RBC lifespan of the bottlenose dolphin is 95 ± 3 days. Like humans, bottlenose dolphins also had low levels of CO in their blood (1.6 ± 0.5 % COHb) and exhaled breath (2.4 ± 1.0 ppm).

It’s all about the ice! Fine-scale features of iceberg haulouts in tidewater glaciers used by harbor seals (Phoca vitulina) in Southeast Alaska

Courtney Pegus¹, Shannon Atkinson DeMaster², John Jansen³

¹University of Alaska Fairbanks, Trinidad and Tobago, ²University of Alaska Fairbanks, ³Marine Mammal Laboratory, NOAA Fisheries, Seattle, WA

Warming climates degrade habitat infrastructures for sub-arctic marine mammals that occupy ice-dominated ecosystems. There is a paucity of information about the impacts of climate-driven changes to calving rates in tidewater glaciers as well as the habitat features that result from the floating ice that is deposited into the nearshore. Several tidewater glaciers in southeast Alaska that are dominated by floating ice attract seasonal aggregations of harbor seals (Phoca vitulina). This study will investigate fine-scale features of floating ice pieces in the nearshore of three tidewater glaciers: Tracy Arm Fjord, LeConte Glacier, and Endicott Glacier and broad-scale features of the nearshore region that surrounds the terminus of these glaciers. Uncrewed aerial systems will capture images of floating ice, and process them with photogrammetry software to measure fine-scale dimensional features of individual floating ice haul outs (with and without seals). Icebergs will have cross-sectional lengths, total area, and slope gradient of the access point measured. Broad-scale features
will be measured by calculating open water: ice-covered ratios (OIR). Additionally, aerial images will be captured at altitudes of 50 m, 100 m, 200 m of three floating icebergs to assess the scalability of measuring dimensional properties from images captured at different elevations. An ANOVA and T-TEST statistic will be used to analyze data. We expect that flat icebergs with a ridge along the boundary would be most frequented by animals and that tidewater glaciers having a high OIR would be more frequented by harbor seals compared to tidewater glaciers having a low OIR. Understanding the influence of habitat quality on population variability in this species will contribute to a better understanding of the larger scale impacts of climate to marine food webs.

**Acoustic strategies showed by Risso’s dolphin (Grampus griseus) in relation to the behavioral context and the group size**

elena papale1, Martina Pelagatti2, Carmelo Fanizza3, Rosalia Maglietta1, Giuseppa Buscaino1, Giulia Cipriano6, Roberto Crugliano7, Roberto Carlucci8

1Institute for the study of Anthropogenic Impacts and Sustainability in the Marine Environment, National Research Council and Department of Life Sciences and Systems Biology, University of Torino, Italy, 2National Research Council, Italy, 3Jonian Dolphin Conservation, Taranto, Italy, 4National Research Council CNR-STIIMA, Jonian Dolphin Conservation, Bari, Italy, 5Torretta Granitola (TP), Italy, 6University of Bari, Bari, Italy, 7Jonian Dolphin Conservation, 8Department of Biology, University of Bari, Bari, Italy

The Risso’s dolphin is poorly studied in the Mediterranean Sea, and scant information is available on its acoustic repertoire. This study aims to deepen the knowledge on the communication coding strategies related to activity state and group size of the species. Acoustic data were collected in 2016, 2017, and 2019 through an omnidirectional hydrophone, jointly with data on the size and the predominant activity state of the focal group. A total of 3 hours and 10 minutes of recordings in which specimens were involved in resting, traveling, and socializing was collected. Click trains, barks, short burst pulses, and whistles were analyzed through iZotope RX software and a semiautomatic Matlab code. The highest emission rate of vocalizations was recorded during socializing. In addition, whistles are very frequency modulated and emitted at higher frequencies compared to other activities. Differently, during traveling, whistles are poorly modulated, at lower frequencies, and with few harmonics. Whistles are longer in duration and the number of harmonics is significantly greater when resting. Furthermore, a higher level of stereotypy is shown by whistles recorded during resting and traveling. These outcomes suggest that whistles may serve different functions such as communication of a larger amount of information at short distances while socializing, and to keep contact during traveling when individuals can see each other. Moreover, whistles could be used as acoustic guidance during resting since their characteristics could convey the emitter directionality. Impulsive signals did not show statistical differences between activities, but the frequency peak decreases with increasing the group size opposite to the inter-click interval that increases. This variation could represent a strategy to ensure the passage of information when an acoustic overlap may occur. This study could promote a greater effort to recognize acoustic strategies in Risso’s dolphin and better understand the extent of its repertoire.

**Potential California sea lion (Zalophus californianus) parturitions after the pupping season**

Lili Pelayo González1, Paula Tercero Dander2, María del Carmen Gutiérrez Osuna3, Luis Miguel Burciaga4, Claudia Hernandez Camacho5
The reproductive cycle of the California sea lion is highly synchronized and annual. This species breeds in the North Pacific Ocean from the Farallon Islands in the United States to Santa Margarita Island in Mexico, including colonies in the Gulf of California. We present data that suggest that some California sea lion pups were born after the pupping season in colonies located in Mexico. In June and July of 2010, we captured and tagged pups to estimate their growth rates during their first year of life on Santa Margarita Island. We returned to the colony in November 2010 and February 2011 to capture and weigh the tagged pups, as well as additional untagged pups. Among the newly captured pups, we found pups of similar weight and size to pups captured in July 2010 (pupping season). When we applied the estimated growth rates for the U.S. colonies in retrospect (with favorable and anomalous environmental conditions such as El Niño), we determined that the pups captured in November 2010 must have been born between August and September of the same year, while the pups captured in February 2011 must have been born between October and November 2010. Another opportunistic observation was obtained in November 2019, when we sighted an apparently pregnant adult female at the Los Islotes colony. This is the first report on births after the pupping season in any pinniped. Our results suggest that under unfavorable environmental conditions (e.g., El Niño events 2009–10, 2019–20), some females show certain plasticity in the duration of the embryonic diapause, delaying the start of gestation. Our results are preliminary, and more studies are needed to determine whether this species’ reproductive cycle is less synchronized than previously thought.

Improving the spatial and temporal scales of species distribution models to mitigate effects of wind energy development and operation on large whales

Daniel Pendleton1, Laura Ganley2, Orla O’Brien3, Jessica Redfern1
1Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, Massachusetts, 2Burlington, Massachusetts, 3Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston

Multiple wind energy development projects are being planned for the east coast of the USA. There has been substantial research on the impacts of renewable energy operations on small cetaceans in European waters, but impacts on baleen whales in the Northwest Atlantic Ocean are largely unstudied. A first step to mitigating potential impacts of intensive construction of marine renewable energy infrastructure, operation and maintenance, is knowing if baleen whale distributions overlap in space and time with development activities. Species distribution models can help inform these issues. However, care needs to be taken that they are tuned to spatial and temporal scales that are meaningful to conservationists, industry, and natural resource managers. The Massachusetts/Rhode Island Wind Energy Area is under active development and construction is expected to begin within the next two years. We have conducted line-transect aerial surveys in this region since 2011 with the express purpose of gathering pre-construction baseline data on marine wildlife habitat use. Using these data, we modeled seasonal habitat use for North Atlantic right, humpback, and fin whales on monthly, seasonal, and climatological timescales. Initial spatially-explicit occupancy and density surface models used bathymetry, sea surface temperature, and chlorophyll-a as predictors of whale distributions. These basic models were able to accurately reproduce broadly observed spatio-temporal patterns of
habitat-use, but had difficulty predicting fine scale spatial differences and summer distributions. We added modeled zooplankton prey, salinity, and thermal and productivity fronts to the occupancy and density surface models to test whether these variables improved the resolution of our predictions. Our results emphasize the importance of building species distribution models that incorporate oceanographic variables that are more closely linked to the mechanisms that determine species distributions, such as prey concentration, at spatio-temporal scales that are both ecologically relevant and meaningful to stakeholders.

SnotBot: UAV-based Protocols for Collecting Blow Samples from Free-ranging Whales
Alicia Pensarosa1, Chris Zadra2, Andy Rogan1, Britta Akerley1, Iain Kerr1, Christian Miller3
1Ocean Alliance, Gloucester, MA, 2Ocean Alliance, 3Christian Miller Photography

Non-invasive UAV technologies have shown immense value in cetacean research, health assessment, and conservation management. Exhaled breath condensate or blow sampling from whales using drone technology is an effective, efficient, and minimally invasive means of collecting biological samples from free-ranging whales. As a relatively novel procedure based on an emerging and unfamiliar technology, questions about choosing a drone, data collection protocols, and pilot ability persist in the cetacean science community. This is inhibiting the potential sample collection and economic benefits this procedure could bring to cetacean science and conservation. In this work, we present best practices for collecting blow samples from whales, including collection protocols, drones, equipment, materials, settings, and safety. This includes drone-based blow collection protocols that have been applied in over 1,500 drone flights collecting over 500 blow sample from six species of whales in six countries from 2015-2021. Utilizing consumer and prosumer drones with adhered Petri dishes, following safety and collection procedures, and sample processing protocols will provide non-invasive sample collection from free-ranging whales to aid in species conservation.

Source levels of 20-Hz fin whale notes measured as sound pressure and ground velocity from ocean-bottom seismometers in the North Atlantic
Andreia Pereira1, Miriam Romagosa2, Carlos Corela2, Monica Silva3, Luis Matias3
1Instituto Dom Luiz, Portugal, 2IMAR-Institute of Marine Research, Vat Number: 502776463, Horta, Portugal, 3IMAR - Institute of Marine Research & Okeanos Center - University of the Azores, Horta, Portugal

Over the last decades, low-frequency underwater noise has increased in some parts of the oceans, and there is an urgent need to understand its effects on marine life. Source level is one major factor that determines the effectiveness of animal signals transmission and their acoustic communication active space. Therefore, it is necessary to estimate average values of source levels and monitor their temporal variability in relation to anthropogenic pressure. Ocean-bottom seismometers (OBSs) are valuable platforms of opportunity to monitor the marine soundscape, including several marine species, because they can record data as pressure fluctuations in the water using a hydrophone, and/or as ground velocity of the seafloor by using a seismometer. This study presents estimates of source levels of 20-Hz fin whale notes simultaneously recorded in these two types of OBS channels and in two areas of the North Atlantic (Azores and southwest of Portugal). It also discusses factors contributing to the variability of the estimates, namely geographical (deployment areas), instrumental (recording channels and sample size), and biological factors (month of detected notes and diving duration). Average source level estimates for the seismometer ranged from 163.4
to 196.9 dB re 1 \(\mu\)Pa m, while the average for the hydrophone ranged from 171.3 to 186.7 dB re 1 \(\mu\)Pa m. Variability was associated with sample size, instrumental characteristics and the month of recordings. Source level estimates were very consistent throughout sequences, and there was no indication of geographical differences. Understanding what causes variation in animal sound source levels provides insights into the function of sounds and helps to assess the potential effects of increasing anthropogenic noise.

First humpback whale resighting between Azorean waters and the Barents Sea (Murman coast, northwestern Russia)

Rui Peres dos Santos¹, Frederick Wenzel², Lindsey Jones³, Ted Cheeseman⁴, Rafael Martins⁵, Антон Чайко⁵

¹R2C2, CCMAR, MICS, UALG, Faro, Portugal, ²Protected Species Branch, NOAA, NMFS, Woods Hole, MA, ³College of the Atlantic, ⁴Southern Cross University, ⁵FUTURISMO AZORES ADVENTURES, Lagoa, Azores, Portugal

Humpback whales (\textit{Megapetera novaeangliae}) are one of the most well studied baleen whale species worldwide and one of the species targeted during the historic North Atlantic whaling period. North Atlantic humpback whales are estimated at >11,000 individuals, consisting of two (or more) distinct population segments. Photographic mark-recapture has determined the migratory connection between the breeding/calving grounds of the West Indies and Cape Verde/West Africa with the feeding areas of the Gulf of Maine, Gulf of St. Lawrence, Newfoundland/Labrador, West Greenland, Iceland, Svalbard and northern Norway, and the migratory stop-over area within the Azorean Archipelago. Northwestern Russia (Barents Sea), a poorly studied region for humpbacks, is recognized as an important fishing area for capelin (\textit{Mallotus villosus}). In the last century, this fish species had collapsed, possibly due to overfishing both in Russian and Norwegian waters, which led to these governments imposing strict fishing restrictions. In the past decades the southern part of the Barents Sea has faced warming ocean temperatures and less sea ice. Here, we present the first photographic match between the Azores and northwestern Russia (Murmansk, Barents Sea). A humpback whale sighted on 15 March, 2019 in the Azorean waters near São Miguel Island was resighted opportunistically on 21 June, 2019 off the Murman coast, Russia. The estimated distance between the two sites is approximately 6778 km, representing a migratory speed of 2.88 km·h⁻¹. Strict regulations on the summer capelin fisheries in the Murman coastline and Barents Sea, along with global warming may lead to new habitats for both fish prey and predators (i.e., humpback whales) to return to this region. This study received Portuguese national funds from FCT - Foundation for Science and Technology through project SFRH/2021

Stress response of an isolated population of bottlenose dolphins to ambient noise.

Betzi Perez¹, Andrew Hendry¹, Shannon Atkinson DeMaster³, Laura J. May-Collado¹

¹McGill University / Panacetacea, Panama, Panama, Panama, ²McGill University, Montreal, Quebec, ³University of Alaska Fairbanks, ⁴University of Vermont, Burlington, VT

Marine mammals are exposed to a diverse array of multiple anthropogenic stressors in their life. Previous research has found evidence that intense boat traffic and its associated noise can generate stress on marine mammals that can be reflected in their behavior and physiological response. Here we studied the whistles of bottlenose dolphins (\textit{Tursiops truncatus}) in two sites of the archipelago of Bocas del Toro, Panama, that contrasts in type of boats and traffic. Almirante Bay is a site dominated by taxi-boats and
Dolphin Bay is a major location for boat-based dolphin watching. To understand the impact of boat traffic and its associated noise in the acoustic behavior and physiology of the Bocas del Toro dolphins we recorded and analyzed 1,726h of acoustic data. Our results show a significant increase in the signature whistles modulation in Dolphin Bay, where tour boats directly interact with the dolphins. Dolphin whistle modulation is thought to be a potential indicator of emotional states including danger, alertness, and stress. This result was supported by a preliminary detection of a higher concentration of the stress hormone cortisol during the high tourist season when a higher number of boats interact with the dolphins. Understanding the behavioral and physiological consequences of boat traffic noise, particularly from dolphin watching activities, will significantly contribute to current management and conservation efforts.

Pre- and post-reproductive feeding of adult and sub-adult male California sea lions (Zalophus californianus, LESSON, 1828) at Isla Lobos, Sonora, Mexico.

JOSE EDUARDO PEREZ LOPEZ¹, Juan Pablo Gallo Reynoso¹, Janitzio Egido Villarreal³, Hector Salvador Espinoza Perez²
¹UNAM, Mexico, ²Center for Research in Food and Development, A.C. (CIAD), ³Institute of Biology, National Autonomous University of Mexico (UNAM).

Studies on the feeding habits of Zalophus californianus have focused on the breeding season, a period in which adult males (AM) focus their resources on breeding and protecting their territory. The objective of this work was to determine the preys of pre- and post-reproductive diet of California sea lion (CSL) AM, on a non-breeding island (Isla Lobos, Sonora México), identifying otoliths and cephalopod beaks (CB) recovered from CSL feces in 2017. Around ~500 AM and SM of CSL, lives in this island. Fifty-four scat were collected in each season (pre- and post-breeding). Otoliths and CB were recovered and taxonomically identified. The most important prey and diet diversity in each season was determined with the importance index (IIMPi) and the Shannon-Wiever index (H') respectively, similarity between seasons was obtained with principal component analysis (PCA). We recovered and identified 1,686 otoliths (1,292 from spring and 394 from autumn) representing 32 species and 10 CB (2 from spring and 8 from autumn) with only two species, as well as crustacean remains; 6 in spring and 27 in autumn samples. The spring IIMPi indicates Californian anchovy (Engraulis mordax) as the most important prey, while graceful mojarra (Eucinostomus gracilis), grunts (Haemulopsis sp.) and longfin halfbeak (Hemirramphus saltator) as the most important in autumn. H' values indicate low diversity for spring (H'=0.795) and high diversity for autumn (H'=3.277). The PCA showed no similarity between the two seasons.

The results showed a preference for fish prey, the majority consumption of common anchoveta during spring indicates a temporal tendency to feed on small prey in large quantities, unlike in autumn, where it feeds on larger prey in low quantities, also consuming more crustaceans. This could be associated with the greater diversity of species in this season, as observed in the H' values, and in ACP for autumn.

Assessment of Disturbances Due to Unmanned Aerial Vehicles (UAVs) on two Harbour Seal (Phoca vitulina) Colonies in Galway Bay, West Coast of Ireland: Recommendations on Best Practices

Maria Perez Tadeo¹, Seán O'Callaghan², Martin Gammell¹, Joanne O'Brien¹
¹Galway-Mayo Institute of Technology, Galway, Ireland, ²Killarney, Co. Kerry, Ireland

During recent years, there has been a significant
increase in the use of Unmanned Aerial Vehicles (UAVs) in marine mammal research and monitoring studies. Although this technology presents advantages in data collection against traditional methods, its potential impacts on marine mammals has raised concerns within the scientific community as these potential impacts remain largely unknown. In order to assess the effects of disturbances on harbour seals (Phoca vitulina) due to a DJI Phantom 4 Pro multi-rotor quadcopter UAV flying at different altitudes, behavioural responses were recorded before, during, and after UAV approaches in two colonies located in Galway Bay, west coast of Ireland. GLMM’s were applied in order to assess the proportion of harbour seals displaying vigilance, resting and locomotion behaviours, and flushing into the water. These behaviours were evaluated as a function of UAV altitude, time of the day, study site, group size and environmental covariates. The presence of an UAV triggered a significant increase in the proportion of seals vigilant and a decrease in resting. A higher level of reaction was observed at flying altitudes between 20 and 10 m. Flushing behaviour was also significantly higher when the UAV was hovering at lower altitudes. The predictor variables tidal state, wind speed, temperature, time of the day, study site and group size showed an influence on harbour seal’s response to the UAV. Sound levels at different flying altitudes were also investigated. Based on the disturbance thresholds identified, we devised recommendations on best practices to be implemented in future research studies on harbour seals using UAV techniques in order to reduce impacts on this species.

Predictive model of sperm whale prey capture attempts from time-depth data

Sergi Pérez-Jorge, Cláudia Oliveira, Esteban Iglesias Rivas, Rui Prieto, Irma Cascão, Monica Silva

Okeanos R&D Centre, Institute of Marine Research, University of the Azores, Horta (Faial) - Azores, Portugal, Portugal, IMAR – Institute of Marine Research, Horta, Portugal, Universidade do Algarve, Faro, Portugal, MARE – Marine and Environmental Sciences Centre; IMAR Centre at the University of the Azores, Horta, Portugal, Institute of Marine Research (IMAR) and Okeanos R & D centre, University of the Azores, and Marine and Environmental Sciences Centre (MARE), Horta, Azores, Portugal, IMAR - Institute of Marine Research & Okeanos Center - University of the Azores, Horta, Portugal

High-resolution sound and movement recording tags offer an unprecedented insight on the fine-scale foraging behaviour of cetaceans, especially echolocating Odontocetes, enabling the calculation of a series of foraging metrics. However, access to these tags is limited by low availability and high-cost. Time-Depth Recorders (TDRs), on the other hand, are inexpensive and widely used in marine mammal studies throughout the world. Unfortunately, data collected by TDRs are bi-dimensional, and quantifying foraging effort from TDRs derived metrics is challenging. The development of accurate foraging indices from TDR data would help democratize this type of research through the use of low-cost, widely available equipment, increase sample size and number of species studied, as well as enable analyses of historical datasets to investigate changes in cetacean foraging activity. Here, data from high-resolution acoustic and movement recording tags from 12 sperm whales were used to build predictive models of the number of buzzes (indicative of prey capture attempts). Generalized linear mixed models were built for dive segments of different lengths (30, 60, 180 and 300 s) and using several predictors based on the knowledge of the species’ foraging behaviour. Average depth, variance of depth and vertical velocity were the best predictors of the number of buzzes. Sensitivity analysis showed that models with segments of 180 s had the best overall predictive performance, with a very good AUC (0.8±0.04),
high specificity (0.7±0.13) and sensitivity (0.92±0.06). Models using 180 s segments overestimated the number of buzzes per dive by 30%. These results demonstrate the feasibility of finding an accurate, fine-scale index of sperm whale prey capture attempts from time-depth data. This work would help to leverage the potential of time-depth data for studying the foraging ecology of sperm whales and the possibility of applying this approach to a wide range of marine species.

**Low Reproduction Indicative of Healthy Dolphin Population?**

Robin Perrtree¹, Jordan Rutland², Jennifer Beaullieu³, Tara Cox¹

¹Savannah State University, Savannah, Georgia, ²Georgia Sea Grant / NOAA Fisheries Office of Protected Resources, Silver Spring, Maryland, ³Oregon State University

Life history indices can be used as proxies for population health in regions without population estimates or trend data. In areas where they have been extensively studied, common bottlenose dolphins (*Tursiops truncatus*) have been shown to be slow to reach sexual maturity (females average 8-10 years) and have inter-birth intervals (IBI) of 3-5 years when the first calf survives. However, recent studies near Savannah, GA, USA demonstrated an average IBI when the first calf survived of 5.5 years. The purpose of this study was to identify females with delayed first reproduction or large gaps after an unsuccessful calf near Savannah, GA, USA to examine the hypothesis that this population is nearing carrying capacity. The calving history of 73 females with sightings in at least 8 of 10 years (2009-2018) were examined. Thirteen of 73 females were first seen as juveniles or adults and were observed 7-11 years before calving, indicating delayed onset of reproduction, with an estimated minimum age of first known calving at 10-15 years. One of these late reproducing moms was rescued from an entanglement as a young individual; we calculated a minimum age of 15 years old before she was observed with her first calf. The aging of other individuals was less precise as some females may have been much older. Five of 73 females were observed with IBIs of 4-8 years after their first calf died. Females with delayed reproduction and prolonged gaps in reproduction could indicate unhealthy individual females. However, combined with the previous metrics calculated for dolphins near Savannah, GA, USA, the lower reproductive rate resulting from these findings are likely to indicate this population is approaching carrying capacity. Examination of individual reproductive rates could be useful in other regions lacking population trend data to estimate population health.

**The assisted maternity: the behaviors and spatial patterns of southern right whales (Eubalaena australis) in Laguna, Santa Catarina, Brazil**

Sther Pessoa¹, Pedro Castilho²

¹Universidade do Estado de Santa Catarina, Laguna, Santa Catarina, Brazil, ²Universidade do Estado de Santa Catarina, Laguna, Brazil

Every year a small concentration of southern right whales migrates to central-southern coast of Santa Catarina State, Brazil to giving birth of their calves. This study aims to evaluate the behaviors and spatial patterns of southern right whales in breeding seasons (July to November) in Laguna, Santa Catarina. Were realized 142.43 hours of observation in a fix point in seasons of 2019 and 2020. It was recorded 88 groups of whales, primarily (n=74) observed in 2020, indicating significant difference between the years. Most of this groups observed were mother-calf pairs (n=53), predominants in the months of August and September. The behavior state was mostly travelling, on top of that our results showed that swimming was slow and with linearity trend (I=0.68; SD = ±0.25), with an average speed of 1.27mph for 2019 and 1.23mph for 2020.
for 2020. Aerial behaviors, such as exposure of different parts of the body and jumps, were only recorded by mother-calf pairs. The highest number of sightings was near to a rocky promontory, that provides calm and protected waters to mothers be with her calves. Our study points the Laguna’s region as an important maternity area for the south right whales, that way the continuation of the monitoring contributes to the conservation of this specie, like regulating the anthropic activities, generating significant information, and evaluating impacts.

Sharing is Caring: Isotopic Niche Overlap in New Zealand Odontocetes
Katharina J. Peters1, Sarah Bury2, Beth Hinton1, Emma Betty1, Guido J. Parra2, Deborah Casano-Bally3, Karen Stockin6
1University of Zurich, Adelaide, Australia, 2NIWA, Wellington, New Zealand, 3Massey University, New Zealand, 4Massey University & Auckland University of Technology, Auckland, Auckland, New Zealand, 5Cetacean Ecology, Behaviour and Evolution Lab, Flinders University, Bedford Park, SA, Australia, 6Massey University, Auckland, New Zealand

The competitive exclusion principle states species cannot coexist if they occupy the same ecological niche. To avoid competitive exclusion, sympatric species can reach niche differentiation via trophic, temporal or spatial segregation. Obtaining direct observations of feeding habits of oceanic species is challenging. However, stable isotope analysis can provide useful insights into recently assimilated prey. We used carbon (δ13C) and nitrogen (δ15N) isotopic values from skin samples to investigate trophic position for 10 species of odontocetes stranded between 2010-2021 in New Zealand. For three sympatric groups, we assessed interspecific trophic niche partitioning: neritic dolphins (bottlenose dolphin, Hector’s dolphin); pelagic odontocetes (common dolphin, dusky dolphin, striped dolphin, killer whale, pygmy sperm whale, long-finned pilot whale); and bathypelagic odontocetes (sperm whale, Gray’s beaked whale). Bottlenose and Hector’s dolphins showed 43% and 34% isotopic niche overlap, respectively, suggesting potential interspecific competition. Considerable isotopic niche overlap was as apparent in the pelagic group, with long-finned pilot whales, common, dusky and striped dolphins reflecting up to 60% overlap, indicating potentially high interspecific competition. Common dolphins overlapped with all other pelagic species to some degree. This species is known to feed opportunistically on available schooling fish and cephalopods, which are targeted by other pelagic species as well. In contrast, killer whales only coincided with common dolphins (33%), likely due to their larger size and different prey selection compared to smaller odontocetes. Pygmy sperm whales overlapped only with common dolphins (43%) and long-finned pilot whales (17%). Bathypelagic odontocetes showed only small niche overlap (10% for sperm whales, 4% for Gray’s beaked whales), likely due to vertical spatial segregation arising from differences in foraging depth and prey selection, including prey size. Coexistence of these species is likely enabled through a degree of trophic niche segregation, coupled with fine scale spatial and/or temporal segregation.

Historical records reveal the magnitude of dolphin killings in the Mediterranean and Northeast Atlantic
Marie Petitguyot4, Giovanni Bearzi5, Graham J Pierce3
4CSIC - Instituto de Investigaciones Marinas, Vigo, Pontevedra, Spain, 5Dolphin Biology and Conservation, Cordenons, Italy, 6Instituto de Investigaciones Marinas, Baiona, Pontevedra, Spain

Between the 16th and 20th century, small cetaceans (particularly dolphins) were killed in large numbers off the coasts of modern Europe
and North Africa, due to perceived competition with fisheries. Here, dolphins were long considered as pests responsible for reduced fish catches and damage to fishing gear. Such conflict was particularly acute between the second half of the 19th century and the first half of the 20th century, when governments from various countries encouraged and subsidized the extermination of small cetaceans. While the precise number of killings and the effects these had on the past and current status of cetacean populations are largely unknown, historical records can help us appreciate their magnitude. Based on an extensive analysis of historical literature (since 1587; \( n = 350+ \) sources) that included landing and bounty reports, we (1) provide qualitative and quantitative information on killings and culling campaigns, (2) identify the species affected, when information on morphology, behaviour and feeding ecology is available, and (3) document the methods used to deliberately kill and harm cetaceans. Our results suggest that tens of thousands of small cetaceans were killed, primarily between the 1850s and the 1970s. Such a high mortality likely had important negative impacts on dolphin population trajectories, particularly in the Mediterranean Sea. In the second half of the 20th century, intentional killings largely stopped, but cetaceans became exposed to a variety of new anthropogenic threats. Reconstructing past exploitation can help understand current population trends, viability and potential for recovery, as well as set meaningful baselines for conservation.

Variation in blubber histology metrics when assessing nutritional status among seven mass stranded pygmy killer whales (Feresa attenuata)

Jana Phipps\(^1\), Ilse Silva-Krott\(^2\), Kristi West\(^3\)

\(^1\)University of Hawaii at Manoa, Health and Stranding Lab, Honolulu, HI, \(^2\)Honolulu, HI, \(^3\)University of Hawaii, Kaneohe Bay, HI

Blubber is a multifunctional tissue essential to the survival of cetaceans. Histological assessment of blubber may be useful in determining odontocete nutritional state but a greater understanding of specific variation across the body is needed. We report on morphological variation in adipocyte area (AA) and adipocyte index (AI) among blubber layers and according to girth axes and sampling planes in 7 pygmy killer whales (Feresa attenuata) of varying age, sex, and reproductive classes that mass stranded; 2 of the 7 animals were part of a prolonged 21 day event. Full-depth blubber sampling was conducted along 3-5 equidistant sampling points on the left side of the body at 5 girth axes based at major anatomical landmarks. 20-35 H&E slides of blubber for each individual were examined and photographed under 10x magnification. Outer, middle and inner blubber layers were defined by morphology and adipose/fibrous connective tissue ratios. AA and AI were determined for each layer at each location using ImageJ. Linear mixed effect models indicated significant differences between blubber layers for both AA and AI, with the outer layer having the lowest AA and middle layer the highest. AI was lowest in the middle layer. Girth axes indicated a trend of higher AA cranially and higher AI caudally. Dorso-ventral sampling planes indicated higher AI in the dorsal area with higher AA in the ventral region. AI in the two adult males that were part of the prolonged mass stranding event grouped together with significantly different AI compared to all of the other 5 whales. This is likely due to poor body condition prior to stranding. Results demonstrated morphological differences in blubber depending on layer, girth axis and body location in pygmy killer whales. Understanding variation across the body is important to the interpretation of single samples for the assessment of nutritional status.

The Genetic Evidence of Six Distinct Cetacean Species in Thai Seas Based on the
Mitochondrial DNA Control Region Haplotypes
Promporn Piboon¹, Kittisak Buddhachat¹, Janine Brown¹, Jatupol Kampuansai¹, Siriwadee Chomdej¹, Patcharaporn Kaewmong¹, Kongkiat Kittiwattanawong¹, Korakot Nganvongpanit²
¹The Faculty of Veterinary Medicine, Chiang Mai University, Chiang, Thailand, ²Phuket, Thailand

The genetic structure of six species, namely Ziphius cavirostris, Neophocaena phocaenoides, Kogia breviceps, Kogia sima, Grampus griseus, Pseudorca crassidens in Thai seas (Andaman Sea and the Gulf of Thailand), which connect to others in adjacent waters and worldwide are poorly understood. The frozen skin tissue from 14 cetaceans (one Z. cavirostris, two N. phocaenoides, three K. breviceps, two K. sima, four G. griseus, and two P. crassidens) stranded on Thai coasts between the years 1998 and 2017 were investigated. Here, we aimed to reveal the maternal lineage and connection of our samples throughout their distribution range using mtDNA control region together with mtDNA control region sequences retrieved from an online database (NCBI) for comparison. The haplotype relationships of each were illustrated through Median Joining Networks (MJNs). Unique haplotypes of five species from Thai seas were found and these unique haplotypes have never been revealed on any database, except for P. crassidens that share haplotypes with the Indo Pacific Ocean. Additionally, shared haplotypes with other regions occurred for K. sima from the Thai Andaman Sea and G. griseus from the Gulf of Thailand. While the sharing of haplotypes to other regions may imply inheritance from the same female ancestor, we speculate that there are also distinct populations with unique genetic structures occurring around Thai seas. Our results could be used for monitoring the alteration of haplotype or maternal genetic diversity in the future as the baseline information of Thai and adjacent waters.

Antarctic Minke Whale Vocalisations In Tropical NW Madagascar
Chris Pierpoint¹, Lorenzo Scala², Stephanie Barnicoat³
¹Seiche Ltd., Bioscience Group, Devon, United Kingdom, ²Seiche Ltd., Bradworthy, Devon, United Kingdom

Passive acoustic monitoring has revealed a lot of information about the vocal repertoire of Antarctic Minke Whales in polar and temperate regions of the Southern Hemisphere. However, few recordings have been made in tropical regions into which this species migrates to breed. We describe a wider variety of pulse train calls recorded in deep water areas offshore NW Madagascar, than has been reported elsewhere. A 12-month monitoring baseline using autonomous recorders (ARUs) moored to the seabed, documented a distinct seasonality in calling in this region, and minke whale presence from June-December (peak Sep-Nov). Calls were dominated by one type (referred to as C6) that has rarely been recorded in higher latitudes and summer feeding areas. Possible explanations for this difference include: a) we sampled a different acoustic population than that recorded during previous studies in the Southern Ocean; b) the C6 call functions as a vocal display whose use is largely limited to areas in which reproductive behaviour occurs.

Epinephrine and cortisol alter the adipose functions and the mobilization of PCBs in adipose tissue slices from Northern Elephant Seal
Laura Pirard¹, Jane Khudyakov², Daniel Crocker³, Liesbeth Van Hassel³, Gauthier Eppe⁴, Donald Smith⁵, Cathy Debier⁶
¹Université catholique de Louvain (UCLouvain), Wavre, Belgium, ²Department of Biological Sciences, University of the Pacific, Stockton, California, ³Sonoma State University, Rohnert Park, CA, ⁴Center for Analytical Research and Technology (CART), Research Unit MolSys,
Liege, Belgium, 4University of California, Santa Cruz, 4UCL, Louvain-la-Neuve, Brabant Wallon, Belgium

Marine mammals are constantly exposed to anthropogenic stressors, which may affect their physiology and health. We have recently developed an innovative approach of precision-cut adipose tissue slices (PCATS) to study in vitro the impact of multiple stressors on the function of an essential endocrine organ: the adipose tissue. In the present study, we investigated the impact of a physiological hormone stress-response on adipose tissue function. Blubber biopsies were collected from 19 northern elephant seal (NES – Mirounga angustirostris) weaned pups (10 early and 9 late weaning pups) from the colony of Año Nuevo (California). PCATS were performed on inner and outer blubber and cultured for 48 hours. To mimic chronic stress, cortisol (2 µM) was applied on PCATS throughout the whole culture duration. Epinephrine (100nM) was added during the last 12 hours of culture to simulate an acute stress. Hormones were applied alone or in combination. The treatments induced significant changes in the expression of genes involved in key processes such as lipolysis, adipokine production and antioxidant defense. Glycerol and free fatty acids quantified in culture media showed a higher lipolytic rate for epinephrine treatments compared to controls and cortisol conditions. Cortisol and epinephrine exhibited an interacting, layer-dependent, effect on adipose tissue biology. Pollutants, already present in blubber before sampling, remained in the tissue regardless of the treatment, highlighting their lipophilicity. The impact of stress hormones on tissue lipidomics is currently under investigation. Our PCATS model is helpful to better understand the consequences of stress events in NES and other marine mammal species of concern.

Strategy For The Conservation Of The Endangered Monk Seal Monachus Monachus In The Madeira Archipelago, Portugal

Rosa Pires1, Fernando Aparicio García2, Pablo Fernandez De Larrinoa3
1IFCN, IP-RAM, Funchal, Madeira, Portugal, 2Fundación CBD-Hábitat, Madrid, Madrid, Spain, 3FUNDACION CBD-HABITAT, Madrid, Madrid, Spain

Based on the results of the LIFE MADEIRA MONK SEAL project (LIFE13 NAT/ES/000974) "Conservation of the monk seal in Madeira and development of a surveillance system of its conservation status" (2014-2019) a Strategy for the Conservation of the population at Madeira archipelago, currently estimated at 23 individuals, has been defined. This is an extremely small and very vulnerable population that requires an effective conservation effort to ensure its viability.

The main pressures of natural origin are the high mortality of young due to the use of sea caves, a suboptimal reproduction habitat, and the potential scarcity of food resources. The main anthropogenic pressures on the population have been identified as being the interaction with fishing activity, particularly with fishing traps and the existence of direct persecution although are not significant, and disturbance by tourist and leisure activities.

The main threats are the risk of interrupted reproduction due to the scarcity of males, the offshore aquaculture activities, disturbances on the habitat and the low genetic variability. Thus, to combat these pressures and threats it was recommended: the prohibition of fishing traps in the Desertas Islands (main habitat for the monk seal) and its modification in Madeira; the increasing of the surveillance effort against illegal fishing and to the whale watching; the assessment of the impact of recreational fishing and of aquaculture on the seals; the assessment of availability of food resources for seals; and the determination of the causes of mortality by gender. Transversal actions are the monitoring of
the conservation status of the species and social information campaigns and citizen science. Currently the strategy it is in action: fishing traps have been, already, banned of the Desertas Islands, and some of the necessary studies are already underway.

**Estimating and managing the combined effects of multiple stressors on marine mammal populations**

Enrico Pirotta1, Daniel Costa2, Ailsa Hall3, Catriona Harris1, John Harwood1, Scott Kraus6, Patrick Miller7, Michael J Moore8, Theoni Photopoulou9, Roz Rolland10, Lorelei Schwacke9, Samantha Simmons12, Brandon Southall13, Len Thomas4, Michael Weise14, Peter Tyack15

1University of St Andrews, St Andrews, Scotland, United Kingdom, 2Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, 3Sea Mammal Research Unit, St. Andrews, United Kingdom, 4CREEM, University of St Andrews, St Andrews, Fife, United Kingdom, 5St Andrews, United Kingdom, 6New England Aquarium, Boston, MA, 7Sea Mammal Research Unit, School of Biology, University of St Andrews, St Andrews, Fife, United Kingdom, 8Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, 9University of St Andrews, St Andrews, United Kingdom, 10New England Aquarium, Ctr Sandwich, NH, 11National Marine Mammal Foundation, 12SMRU Consulting, Harrogate, United Kingdom, 13Southall Environmental Associates, Inc., Aptos, California, 14Office of Naval Research, 15University of St Andrews, St Andrews

Marine mammals and their habitats are exposed to an expanding diversity and intensity of human activities, in the wider context of increasing pressure from anthropogenic climate change. Estimating how these multiple stressors affect individuals, populations, and ecosystems is thus of growing importance, but their combined effects often cannot be reliably predicted from the individual effects of each stressor. However, we largely lack a mechanistic understanding of how diverse effects may combine, as well as appropriate analytical tools to predict outcomes. We propose a conceptual framework that captures and reconciles the variety of existing approaches for assessing the combined effects of multiple stressors. Specifically, we show that all approaches effectively lie along a continuum, reflecting increasing assumptions around the mechanisms that regulate the action of single stressors (when operating in isolation) and any interaction (when operating in combination). An emphasis on mechanisms improves analytical precision and predictive power, but comes at the risk of introducing bias if the underlying assumptions are incorrect. We illustrate how this continuum can be formalised into specific analytical methods, using an example of whales feeding on limited prey resources while simultaneously being affected by entanglement in fishing gear. In practice, case-specific management needs and data availability will guide the exploration of the stressor combinations of interest and the selection of a suitable trade-off between precision and bias. We argue that the primary goal for management should be to identify the most practical and effective ways to reduce stressors and combinations of stressor levels in order to ensure that the risk of adverse impacts on populations and ecosystems remains below acceptable thresholds.

**Automated Detection of Whales in the Atlantic Northeast**

Olivia Pisano1, Boris Worm1

1Dalhousie University, Halifax, Nova Scotia

Whales are becoming increasingly threatened by climate change and anthropogenic sources of injury and mortality, such as vessel strikes and fishing gear entanglement. As such, there is an urgent need for the near real-time monitoring of whales around the globe. Traditional survey
methods are financially and logistically restricted in their ability to detect and monitor whales across their entire range. Developing new methods to track whale populations is required to expand our understanding of how whales spatially and temporally interact with a variety of dynamic threats. Very High Resolution (VHR) satellite imagery and machine learning have been successfully used to detect and count various marine and terrestrial taxa and are promising new tools for wildlife assessment and conservation. This project is concerned with the development of an automated survey method that uses aerial and VHR satellite imagery analyzed with a machine learning (ML) model to detect and identify whales. An ML model was developed using a combination of aerial, drone, and satellite imagery to automatically detect and identify whales in the Atlantic Northeast, with a particular focus on the Gulf of St. Lawrence. Detections made from this imagery were used to conduct spatio-temporal analyses by species and for the overall whale community in relation to vessel traffic patterns. Results from these analyses are currently in preparation but will be used to help resolve human-wildlife conflicts in the Gulf of St. Lawrence. The use of VHR satellite imagery in conjunction with automated detection is a customizable approach that can be applied to answer questions about whale occurrence and movements, particularly in areas with intense anthropogenic activities. Understanding such interactions is critical to the development of protective measures and management strategies essential to whale conservation in Canada and around the world.

Forty-Year Historical Analysis of Marine Mammal Strandings in Texas, From 1980 – 2019
Sarah Piwetz¹, Errol Ronje², Heidi Whitehead³
¹Texas Marine Mammal Stranding Network, Galveston, Texas, ²NOAA National Centers for Environmental Information, Stennis Space Center, MS, ³Texas Marine Mammal Stranding Network, Galveston, TX

Long-term trends in marine mammal stranding patterns can provide useful information on basic life history parameters, spatiotemporal distribution, natural and human-related mortality events, and potentially vulnerable populations. Between 1980 and 2019, a total of 5,301 marine mammal strandings were recorded in Texas, USA. In total, 23 species were identified, including 19 odontocete species, 3 mysticete species, and 1 sirenian species. Common bottlenose dolphins (Tursiops truncatus) stranded most frequently, making up 94% of the total. Six unusual mortality events occurred with causes attributed to disease, harmful algal blooms, or unknown etiologies. Common bottlenose dolphin stranding events increased significantly in late winter/early spring, with an early onset in southern Texas, and had a consistent peak in March involving primarily calves and adults. Spatial analyses using kernel density estimation within 7 coastal Texas stock management areas, delineated by the National Marine Fisheries Service, identified potential hotspots for common bottlenose dolphin strandings near higher human population density. Peak density estimates for strandings in each stock area ranged from 0.32 – 4.6 km² for presumed bay, sound, and estuarine (BSE) stocks and 0.82 km² for the presumed Western Gulf of Mexico Coastal Stock. Common bottlenose dolphin stranding events were positively male-biased and sexual dimorphism was observed in total body length of adults, with significantly greater length in males. For all stranding records where human interaction (HI) could be determined as ‘yes’ or ‘no’, 24% were positive for HI, with the highest proportion of HI events occurring in the southern-most BSE stock area; however, it is unknown how many HI cases contributed to mortality. This longitudinal study provides a comprehensive overview of marine mammal stranding patterns in Texas and serves as a useful resource for stranding investigators and Gulf-wide natural resource managers.
Trophic niche overlap between sympatric harbour seals (Phoca vitulina) and grey seals (Halichoerus grypus) at the southern limit of their European range (Eastern English Channel)

Yann Planqué¹, Jérôme Spitz², Matthieu Authier³, Gaël Guillou¹, Cécile Vincent⁴, Florence Caurant⁵
¹Centre d’Études Biologique de Chizé (CNRS - La Rochelle Université, France), La Rochelle, France, ²Observatoire Pelagis UMS 3462 LRUniv - CNRS, La Rochelle, Nouvelle-Aquitaine, France, ³Observatoire Pelagis UMS 3462 LRUniv - CNRS, La Rochelle, Nouvelle Aquitaine, France, ⁴University of La Rochelle, La Rochelle, France, ⁵Centre d’Études Biologiques de Chizé (UMR 7372 CNRS - La Rochelle Université), La Rochelle, France

Sympatric harbour (Phoca vitulina) and grey seals (Halichoerus grypus) are increasingly considered potential competitors, especially since recent local declines in harbour seal numbers while grey seal numbers remained stable or increased at their European core distributions. A better understanding of the interactions between these species is critical for conservation efforts. This study aimed to identify the trophic niche overlap between harbour and grey seals at the southern limit of their European range, in the Baie de Somme (BDS, Eastern English Channel, France), where numbers of resident harbour seals and visiting grey seals are increasing exponentially. Dietary overlap was identified from scat contents using hierarchical clustering. Isotopic niche overlap was quantified using δ¹³C and δ¹⁵N isotopic values from whiskers of 18 individuals, by estimating isotopic standard ellipses with a novel hierarchical model developed in a Bayesian framework to consider both intra- and interindividual variability. Foraging areas of these individuals were identified from telemetry data. The three independent approaches provided converging results, revealing a high trophic niche overlap due to consumption of benthic flatfish. Two diet clusters were dominated by either small or large benthic flatfish, these comprised 85.5% [CI95%: 80.3-90.2%] of harbour seal scats and 46.8% [35.1-58.4%] of grey seal scats. The narrower isotopic niche of harbour seals was nested within that of grey seals (58.2% [22.7-100%] overlap). Grey seals with isotopic values similar to harbour seals foraged in coastal waters close to the BDS alike harbour seals did, suggesting the niche overlap may be due to individual grey seal strategies. Our findings therefore provide the basis for potential competition between both species (foraging on benthic flatfish close to the BDS). We suggest that a continued increase in seal numbers and/or a decrease in flatfish supply in this area could cause/amplify competitive interactions and have deleterious effects on harbour seal colonies.
Mandela University, Port Elizabeth, South Africa, 12Mammal Research Institute, University of Pretoria, South Africa, 13Department of Oceanography, Institute for Coastal and Marine Research, Nelson Mandela University, Port Elizabeth, South Africa, 14Mammal Research Institute Whale Unit, University of Pretoria, South Africa, Hermanus, Western Cape, South Africa

The SouSA Consortium is a formalised network of scientists and conservationists which was established in 2016 to improve our understanding of the endangered Indian Ocean humpback dolphin (Sousa plumbea) off South Africa. Our first collaborative project aimed at refining a national population estimate and investigating movements between research sites using available photo-identification. It produced alarming results as it identified less than 250 unique animals divided into only two communities. Further research showed declining population numbers, but because the South African marine environment is in a constant state of significant change from both natural and anthropogenic factors, identifying individual threats and solutions is challenging. It was the Consortium’s belief that continued investigation of individual contributing factors and their effects was important, but also time-consuming – time the endangered humpback dolphin population may not have. In an attempt to avoid another case of “documenting extinction”, we conducted a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis, which helped identify areas of importance for concerted action. Results revealed the top strength to be improved collaborations through the formation of the Consortium, while the top opportunity was the formalization of the endangered conservation status of the species in South African waters. However, both the top weakness and threat identified are that the rapid decline in humpback dolphin numbers is not caused by one single factor, but rather by the cumulative effects of several factors, making conservation action challenging. Thus the Consortium proposes that the action points identified by the SWOT will be prioritised (engagement with decision makers, education etc.), but simultaneously future research should improve our understanding of the various threats and identify the stakeholders, resources and potential mitigation options to develop a Conservation Plan. Emerging tools and frameworks to assess/model multiple stressors on the species will be explored using the available data.

Entangled whales in the Northeast South Pacific: A passive growing threat in Peru and Ecuador

Angela Plüss1, Carlos Francisco Yaipen-LLanos2
1ORCA PERU - Organization for Research and Conservation of Aquatic Animals, Lima, 2Organization for Research and Conservation of Aquatic Animals - ORCA PERU, Surco, Lima, Lima, Peru

Marine debris and active fishing gear is a serious threat for large whales around the world, with casualties widely documented in multiple species. However, in the northeast South Pacific Ocean, between Ecuador and Peru, where large cetaceans transit through for the breeding season in winter, little is known about the impact of entanglements on whales. The aim of this work is to assess the incidence and risk of entanglement for large cetacean species while through Peru and Ecuador. Following both a retrospective documental analysis and transversal field assessment of live and dead cetacean stranding reports, our data log collected information on whale species, stranding location and time, gender, estimated age class by size, and most noticeable the association of the specimen with either marine debris, fishing gear or entanglement lesions presented. The incidence of entanglement was confronted with the proportion of the historical record of strandings of large cetaceans in the area between 2006 and 2019. Entanglement characterization included whales
with fishing gear, nets or marine debris attached to flippers, flukes or surrounded the overall body. Entanglement cases comprised 32.65% (N=49) of large cetacean strandings recorded. Our findings revealed that all entanglement cases involved Humpback whales (*Megaptera novaeangliae*), and represented 55.17% (n=29) of *M. novaeangliae* strandings. Juvenile specimens were involved in 50% of the cases. Lethality rate was 57.89% of cases were interactions with fishing gear happened at open sea. Whale carcasses appearing in the beach are buried by coastal city halls. Live stranded cases were assisted on the beach by local fishermen removing the entangled gear and reintroducing the whale with the support of the Peruvian Navy and the public. Over the past 10 years, entanglement cases have multiplied per five times the annual frequency, demonstrating that entanglements could increase slowly and dramatically in years to come.

**Continued acoustic monitoring of the endangered Cook Inlet beluga whale population**

Lori Polasek¹, Manuel Castellote², Christopher Garner³, Mandy Keogh⁴, Arial Brewer⁵, Tom Gage⁶, Justin Jenniges⁷

¹Alaska Department of Fish and Game, Junea, Alaska, ²Marine Mammal Laboratory. National Marine Fisheries Service. NOAA, Seattle, us, ³Joint Base Elmendorf Richardson, U. S. Air Force. Conservation, JBER, AK, ⁴NOAA Alaska Region, Juneau, AK, ⁵University of Washington, Seattle, Washington, ⁶Alaska Department of Fish and Game, Anchorage, AK, ⁷Alaska Department of Fish and Game, Juneau, AK

The endangered Cook Inlet beluga population is non-migratory and located in south-central Alaska. Estimated at <300 individuals, it is declining more rapidly than previously thought. The Recovery Plan highlights a paucity of information on basic ecology impeding proper management decisions. The Alaska Department of Fish and Game and the National Marine Fisheries Service are collaborating on a long-term passive acoustics monitoring program since 2008 to address crucial information gaps. Year-round seasonal distribution and feeding occurrence is described for key areas within the critical habitat. Acoustic detections are greater in the upper inlet during summer, peaking in known concentration areas at times of anadromous fish spawning runs, including large sections of rivers. Foraging peaks coincide with the presence of primarily Pacific salmon species and smelt, from spring to fall. Lower levels of feeding activity in winter suggest a lack of feeding aggregations in these areas, but further efforts on understanding what prey is being targeted in winter is ongoing. Long-term passive acoustic monitoring has proved to be a very useful approach to further our understanding of habitat use by this endangered species, identifying the seasonal importance of specific areas within the critical habitat and highlighting prey species.

**Drone-collected blow provides insights into the respiratory microbiome of cetaceans**

Jennifer Polinski¹, Andy Rogan², Iain Kerr², Chris Zadra³, Alicia Pensarosa², Matthew Harke¹

¹Gloucester Marine Genomics Institute, Gloucester, Massachusetts, ²Ocean Alliance, Gloucester, MA, ³Ocean Alliance

Like other mammals, cetaceans are susceptible to infections of the pulmonary system, and understanding the prevalence and severity of such infections is key to assessing population health and developing informed management plans. Exhaled breath condensate, or blow, provides a preview of the microorganisms inhabiting cetaceans’ respiratory tracts, including those associated with a healthy microbiome and potential pathogens. Over the past decade, unmanned drones have emerged as a noninvasive platform for blow collection. However, baseline data across geographic locations, multiple species, and over time that would allow for
identification of the characteristics of a healthy blow microbiome is still lacking. We present here genetic analysis of 16S small subunit (SSU) rRNA gene sequencing collected via the SnotBot® from three cetacean species in three distinct geographic regions. These include blow from humpback whales in the northwestern Atlantic, sperm whales in the east Atlantic, and blue whales in the Pacific Ocean. These data provide novel insights into cetacean blow microbiomes and lay the framework for assessing whale pulmonary health via noninvasive platforms.

Monitoring cetaceans and noise along the Malin to Islay front using innovative acoustic technologies as part of the SeaMonitor project Morgane Pommier¹, Simon Berrow², Diego del Villar³, Ross O'Neill⁴, Ross McGill³, Joanne O'Brien⁵

¹Atlantic Technological University, Galway, Ireland, ²Galway-Mayo Institute of Technology, ³Loughs Agency, Derry ~ Londonderry, United Kingdom, ⁴Marine Institute, Oranmore, Ireland, ⁵Galway-Mayo Institute of Technology, Galway, Ireland

Cetaceans are highly mobile, often wide-ranging, nomadic, or migratory species, oblivious to human boundaries. This poses serious challenges to their conservation, requiring transnational monitoring efforts and implementation of coherent measures across population range. Often, for logistical, financial, and jurisdictional reasons, data collection programs are restricted to national waters and tend to leave marginal areas under-surveyed. The Malin Shelf in the Northeast Atlantic straddles Irish and UK EEZs. Despite being located between two known cetacean hotspots (Northwest Scotland & Southwest Ireland), information on species occurrence, movements and ecology in the area remains relatively scarce. In the Republic of Ireland in particular, the north coast has received little monitoring effort compared to other coastal sites or offshore deep slopes habitats.

SeaMonitor is a cross-border collaborative EU INTERREG VA funded research project aiming to improve the understanding and conservation of mobile marine species between Ireland, Northern Ireland, and Scotland. Yearlong continuous datasets are gathered from an array of five static listening stations deployed at the outer mouth of the North Channel, between Malin Head (Co. Donegal, Ireland) and Islay (Co. Argyll, Scotland) from 2020 to 2022. Monitored with C-PODs or SoundTraps, temporal patterns in cetacean habitat-use and ocean soundscape are modelled and compared across sites. Spatial coverage is enhanced by complementary glider-based passive acoustic monitoring over the Malin Shelf, particularly near a dynamic tidal front, the Islay front. Outcomes of this project will contribute to address knowledge gaps and will feed into the MPA designation process for Annex II species (Habitat Directive), such as the harbour porpoise Phocoena phocoena. Noise levels will be reported following the Marine Strategy Framework Directive guidelines. Together, data on cetacean occurrence and potential threats should inform management to minimise disturbance from on-going and future activities in the area.

Inter-individual foraging behaviour and diet variation in Eastern Canada-West Greenland bowhead whales.

Tommy Pontbriand¹, Steven Ferguson², Gail Davoren¹, Cory Matthews², Corinne Pomerleau¹, Brent Young⁴, Sarah Fortune⁴

¹University of Manitoba, Winnipeg, Manitoba, ²Fisheries and Oceans Canada, Winnipeg, Manitoba, ³Department of National Defence, ⁴Fisheries and Oceans Canada, Winnipeg, MB, ⁵Fisheries and Oceans Canada, British Columbia

Under the current global climate changes, the Arctic is one of the fastest changing environments and endemic whale species such as bowhead whales (Balaena mysticetus) face an
array of threats. For example, the rapid decline of sea ice cover has led to a polar expansion of killer whale predators, and increased surface temperatures have resulted in changes in zooplankton species composition where low energy temperate species dominate. As the energetic quality of prey decreases, bowhead whales may struggle to meet their large energetic requirements over time. In order to quantify the energetic consequences of climate induced shifts in prey quality, we first need to know what foraging strategies different individuals of bowhead whales employ, and if those strategies impact their diet. Eastern Canada-West Greenland (ECWG) bowhead whales are known to display inter-individual variability in diet; however the mechanism is unknown. Our objective is to test alternative mechanisms (i.e., foraging behaviour and individual specialization) driving inter-individual diet variation while controlling for age, sexual, spatial, and temporal heterogeneity. We use a coupled approach of biotracers (stable isotopes and fatty acids) from biopsy samples to characterize diet, and dive data from telemetry and time depth recorder tags to characterize foraging behaviour. Results showed that foraging behaviour and body length are significant predictors of diet whereby larger whales conducted deeper and longer foraging dives, resulting in different diet signatures compared to smaller whales. No sexual nor annual differences in diet were observed. However, whales tagged in different regions (Foxe Basin vs. Cumberland Sound) at the same time of the year (summer) displayed significant diet differences, suggesting the use of different summer foraging areas with potentially distinct prey compositions. Overall, our results will help to assess the potential of ECWG bowhead whales to cope with current and future large-scale changes in prey.

Changes in Sea Ice and Range Expansion of Sperm Whales in the Eclipse Sound Region of Baffin Bay, Canada

Natalie Posdaljian¹, Caroline Soderstjerna², Joshua M. Jones³, Alba Solsona Berga⁴, John Hildebrand¹, Kristin Westdal⁵, Alex Ootoowak⁶, Simone Baumann-Pickering⁷

¹Scripps Institution of Oceanography, La Jolla, California, ²UC San Diego - Scripps Institution of Oceanography, ³Scripps Institution of Oceanography, La Jolla, CA, ⁴Scripps Institution of Oceanography, ⁵Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, ⁶Oceans North, Winnipeg, Manitoba, ⁷Scripps Institution of Oceanography, UCSD, La Jolla, California

Sperm whales are a cosmopolitan species but are only found in ice-free regions of the ocean. Understanding the distribution of sperm whales in Baffin Bay in the eastern Canadian Arctic becomes increasingly important as the region undergoes rapid loss of sea ice and ocean warming. In 2014 and 2018, sperm whales were sighted in Eclipse Sound, northwest Baffin Bay: the first recorded uses of these habitats by sperm whales. We investigated sperm whale distribution near the Eclipse Sound using open-source visual sighting data and passive acoustic data from two recording sites between 2015 and 2019. We also relate acoustic presence of sperm whales to the mean sea ice concentration near the recording sites. We found no records of sperm whale sightings near Eclipse Sound outside of the 2014/2018 observations. Our acoustic data told a different story. Sperm whale echolocation clicks were recorded from 2015-2019 in the late summer and fall months. Sperm whale presence increased over the 5-year study duration and was closely related to the minimum sea ice concentration each year. Sperm whales, like other cetaceans, may be ecosystem sentinels, or indicators of ecosystem change. Increasing presence of sperm whales in the Eclipse Sound region could indicate range expansion of sperm whales as a result of changes in sea ice. Monitoring climate change-induced range expansion of sperm whales in this region is important to understand how increasing presence
of a top-predator might impact the Arctic food web.

Causes of Mortality for Endangered Antillean Manatees in Cuba
James Powell1, Anmari Alvarez Aleman1, Charles Jacoby2, James Austin3, Thomas Frazer4, Eddy Garcia Alfonso5
1Clearwater Marine Aquarium Research Institute, 2University of Florida, 3Department of Wildlife Ecology and Conservation, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida, 4University of Florida, Gainesville, Florida, 5Empresa de Flora y Fauna, Cuba

The Antillean manatee is categorized as endangered by the IUCN primarily due to its low abundance. Further declines in abundance are expected due to a group of human-related threats that include illegal hunting, fatal interactions with fishing gear, increasing watercraft traffic, and pollution. The nature of current threats is not well described for every critical population of manatees. In particular, threats to manatees have not been documented or evaluated in a systematic manner in coastal waters surrounding Cuba, which is a major reason why plans specifically addressing conservation of manatees in Cuba have not been implemented. To address this lack of information, we assessed patterns in various threats by reviewing reports of stranded (alive or dead) and captured manatees, with some reports being historical and others consistently available since 2001. For 94% of the contemporary cases, carcasses of dead animals were reported; the remainder (6%) involved live manatees and subsequent efforts to rescue and rehabilitate them. Documented causes of mortality included poaching (38%), entanglement in fishing gear (10%), deaths of dependent calves (2.5%), and boat collisions (2.5%). The cause of death for the remaining 47% of reports could not be determined. Mortalities were highest in areas with intensive commercial fishing effort, and mortalities in marine protected areas indicated a need for improved management. These initial findings provide the first estimates of the magnitude of mortality of manatees in Cuba and yield valuable insights into the causes of deaths. The existence of intense and poorly regulated fishing in certain areas, including protected areas, represents a potentially significant threat to manatees. The effects and management of this activity, especially in habitats that are critical for manatees, merit further attention.

Modeling protected species distribution and habitat to inform siting and management of pioneering ocean industries: A case study for U.S. Gulf of Mexico aquaculture
Nicholas Farmer1, Jessica Powell2, Kenneth Riley3, James Morris1, Melissa Soldevilla1, Lisa Wickliffe1, Jonathan Jossart3, Jonathan MacKay5, Alyssa Randall1, Gretchen Bath1, Penny Ruvelas6, Kristy J. Long7, Laura Gray8, Wendy Piniak9, Jennifer Lee10, Lance Garrison11, Robert Hardy9, Kristen Hart12, Chris Sasso13, Lesley Stokes13

Marine Spatial Planning (MSP) provides a process that uses spatial data and models to evaluate environmental, social, economic, cultural, and management trade-offs when siting ocean industries. Aquaculture is the fastest-
Growing food sector in the world. The U.S. has substantial opportunity for offshore aquaculture development given the size of its exclusive economic zone, habitat diversity, and variety of candidate species for cultivation. However, many protected species rely upon habitats that overlap with promising aquaculture areas. Aquaculture can adversely affect protected species across a range of activities including resource surveys, construction, operation and management, and decommissioning. Anticipated impacts include increased noise levels, substrate and water quality degradation, alteration of ocean climate and flow characteristics, impediments to movement and migration, habitat displacement, and entanglement, injury, or direct mortality. In 2020, the U.S. Gulf of Mexico was identified as one of the first regions to be evaluated for offshore aquaculture opportunities as directed by a Presidential Executive Order. We developed a generalized scoring model for protected species data layers that captures vulnerability using species conservation status and trend. We applied this approach to data layers for eight species listed under the U.S. Endangered Species Act, including five species of sea turtle, Rice's whale, smalltooth sawfish, and giant manta ray. We evaluated several methods for scoring (e.g., arithmetic mean, geometric mean, product, lowest scoring layer) and created a combined protected species data layer that was used within a multi-criteria decision-making modeling framework for MSP. The product approach for scoring provided the most logical ordering of and the greatest contrast in site suitability scores. This approach provides a transparent publicly-accessible method to identify aquaculture site alternatives with the least conflict with protected species. These modeling methods are transferable to other regions, to other sensitive or protected species, and for spatial planning for other ocean-uses.

The Role of Diet Quality on Divergent Population Trends of California Sea Lions (Zalophus californianus) in Mexico and the USA

Ana Pozas¹, David Rosen², Andrew W. Trites², Claudia Hernández Camacho³
¹University of British Columbia, Marine Mammal Research Unit, ²UBC Marine Mammal Research Unit, Vancouver, British Columbia, ³CICIMAR, La Paz, Baja California Sur, Mexico

Although the global population of California sea lions (Zalophus californianus) has increased in recent decades, declines have occurred throughout the Gulf of California (GoC), Mexico at an annual rate of 2% between 1984 – 2015. In sharp contrast, sea lion populations within the Channel Islands, USA (the major species breeding site) have increased at a rate of 7% between 1975 – 2014. We investigated whether differences or shifts in diet could explain the divergent population trajectories between and within groups of rookeries in the GoC and Channel Islands. We divided the GoC rookeries into multiple zones based on similarities in geographic proximity and population trajectories. We also combined published and unpublished dietary data and census counts to test whether there is a relationship between historical (1980s – present) population trends and aspects of diet quality, including energy density, prey availability, and diet diversity. Preliminary findings suggest there is a link between diet quality and population trends, which may be key to understanding the population drivers and future trajectories of California sea lions and other pinnipeds.
Using Unmanned Aerial Systems (UAS) to Understand Distribution and Habitat Use Patterns of Common Bottlenose Dolphins (Tursiops truncatus) Across Varying Salinities in Charleston, South Carolina, USA
Nicole Principe1, Norman Levine2, Wayne McFee3, Brian Balmer4, Joseph Ballenger5
1College of Charleston, 2College of Charleston, Charleston, South Carolina, 3NOAA, Charleston, South Carolina, 4National Marine Mammal Foundation, Johns Island, SC, 5South Carolina Department of Natural Resources, Charleston, South Carolina

The use of unmanned aerial systems (UAS) is quickly becoming a widely applied technique to collect high-resolution aerial imagery of marine mammals over extended distances and across habitat types. The Charleston Estuarine System Stock (CESS) of bottlenose dolphins exhibit long-term site fidelity to the Charleston Harbor as well as the Ashley, Cooper, and Wando Rivers. In the Cooper River, dolphins have been intermittently sighted in upper regions with salinities lower than what is considered preferred dolphin habitat (< 8ppt). The goal of this study was to conduct UAS surveys along the Cooper River and surrounding waters (N = 8 sites) to: 1) determine distribution patterns across survey sites, 2) quantify behavior and establish habitat use patterns, and 3) evaluate the effectiveness of using UAS to study dolphins in a coastal estuary. A total of 304 UAS flights were conducted across survey sites between Jan 2021 and Jan 2022. Dolphins were observed at five survey sites (N= 94 sightings, detection rate = 0.75 dolphins/hour of survey time). Dolphins were encountered year-round across high salinity sites (> 15 ppt) (N = 84 sightings), while infrequently encountered at low salinity sites (< 15 ppt) (N = 10 sightings). Behavioral observations were conducted on a subset of video clips with dolphin encounters. A total of 88 focal follows of dolphins were analyzed to determine behavior. Traveling and foraging were the most commonly observed behaviors. Our findings support the use of UAS in surveying for bottlenose dolphins in a salt marsh estuary. Our results suggest that dolphins do utilize low salinity habitat in the upper Cooper River, but their presence in those regions may vary seasonally. Based on UAS observations of dolphins foraging in that area, one potential explanation for dolphins utilizing otherwise unsuitable habitat may be for exploiting additional prey resources.

Vocal correlates of arousal in bottlenose dolphins (Tursiops spp.) in human care
Rachel Probert1, Anna Bastian2, Simon Elwen1, Bridget James3, Tess Gridley5
1University of KwaZulu-Natal, Durban, KwaZulu-Natal, South Africa, 2University of KwaZulu-Natal, Durban, South Africa, 3Stellenbosch University, Cape Town, South Africa, 4Stellenbosch University, South Africa, 5University of Cape Town, Cape Town, Western Cape, South Africa

Bottlenose dolphins are highly social marine mammals and the most common cetacean found in captivity. Human-controlled regimes can entrain behavioural responses and may impact animal welfare. Understanding how schedules impact animal behaviour can be a valuable tool to improve welfare, however information on behaviour in the absence of husbandry staff remains rare. We collected overnight acoustic data of whistles to investigate acoustic behavioural patterns linked to dolphinarium routines. Whistles are important communication signals which dolphins use as a contact call. Changes in production rates or whistle characteristics, such as duration and frequency, reflect shifts in dolphins’ arousal states, making them ideal candidates to investigate effects of schedules on their emotional states. We investigated vocal behaviour of ten dolphins housed in three social groups at uShaka Sea World dolphinarium focussing on overnight behaviour, housing decisions, weekly patterns, and transitional periods between presence and
absence of husbandry staff. Recordings were made from 17h00 – 07h00 over 24 nights, spanning May to August 2018. Whistle production rate decreased soon after husbandry staff left the facility, was low overnight, and increased upon arrival. Results indicated elevated arousal states associated with the morning arrival and presence of husbandry staff and heightened excitement associated with feeding. Housing in pool configurations which limited visual contact between certain groups were characterised by lower vocal production rates. Signature whistle production was greater over the weekends compared to weekdays however total whistle production did not differ between weekends and weekdays. Heightened arousal associated with staff arrival was reflected in the structural characteristics of signature whistles, particularly maximum frequency, frequency range and number of whistle loops. Overall, these results revealed a link between scheduled activity and associated behavioural responses, which can be used as a baseline for future welfare monitoring where changes in normal behaviour may reflect shifts in welfare state.

The northernmost haulout site of South American sea lions and fur seals in the western South Atlantic
Natalia Procksch1, M. Florencia Grandi1, Paulo Henrique Ott2, Karina Groch1, Paulo A.C. Flores3, Marcelo Zagonel4, Enrique A. Crespo5, Rodrigo Machado6, Guido Pavez7, Murilo Guimarães7, Maurício Veronez8, Larissa R. Oliveira8
1Universidade do Vale do Rio dos Sinos, Novo Hamburgo, Rio Grande do Sul, Brazil,
2Universidade Estadual do Rio Grande do Sul (UERGS) & Grupo de Estudos de Mamíferos Aquáticos do Rio Grande do Sul (GEMARS), Osório, Rio Grande do Sul, Brazil, 3Instituto Australis - Right Whale Project, Imbituba, Brazil, 4Área de Proteção Ambiental (Environmental Protection Area) Anhatomirim, ICMBio, MMA, Florianópolis, SC, Brazil, 5Centro Nacional Patagónico CONICET, Puerto Madryn, Chubut, Argentina, 6Grupo de Estudos de Mamíferos Aquáticos do Rio Grande do Sul - GEMARS, Torres, RS, Brazil, 7Universidad de Chile, Santiago, Chile, 8Laboratório de Ecologia de Mamíferos, Universidade do Vale do Rio dos Sinos (UNISINOS), São Leopoldo, Rio Grande do Sul, Brazil

We present estimates of the seasonal and spatial occupation by pinnipeds of the Wildlife Refuge of Ilha dos Lobos (WRIL), based on aerial photographic censuses. Twenty aerial photographic censuses were analysed between July 2010 and November 2018. To assess monthly differences in the numbers of pinnipeds in the WRIL we used a Generalized Linear Mixed Model. Spatial analysis was carried out using Kernel density analysis of the pinnipeds on a grid plotted along the WRIL. Subadult male South American sea lions (Otaria flavescens) were the most abundant pinniped in the WRIL. Potential females of this species were also recorded during half of the census. The maximum number of pinnipeds observed in the WRIL was 304 in September 2018, including an unexpected individual southern elephant seal (Mirounga leonina), and a high number of South American fur seal yearlings (Arctocephalus australis). However, there was no statistically significant difference in counts between months. In all months analysed, pinnipeds were most often found concentrated in the northern portion of the island, with the highest abundances reported in September. This study confirms the importance of the WRIL as a haulout site for pinnipeds in Brazil, recommends that land research and recreational activities occur in months when no pinnipeds are present, and encourages a regulated marine mammal-based tourism during winter and spring months.
Cetacean species richness in relation to anthropogenic impacts and areas of protection in the South African Exclusive Economic Zone
Jean Purdon1, Fannie Shabangu2, Marc Pienaar3, Michael J Somers4, Ken Findlay5
1University of Pretoria, South Africa, 2Fisheries Management Branch, Department of Forestry, Fisheries and the Environment, Cape Town, Western Cape, South Africa, 3South African Environmental Observation Network, uLwazi Node, Pretoria, Gauteng, South Africa, 4Mammal Research Institute, Centre for Invasion Biology, Department of Zoology and Entomology University of Pretoria, Pretoria, Gauteng, South Africa, 5Centre of Sustainable Oceans Economy, Cape Peninsula University of Technology, Cape Town, South Africa

The world’s oceans are subject to the multiple impacts of human activity and to the consequent threats to the health of many and varied ocean ecosystems. Oceans around South Africa are no exception and, with the need for economic growth in the country, anthropogenic stressors on ocean resources are rapidly increasing. In this study, we investigated 14 different anthropogenic stressors that impacted ocean health between 2003 and 2013, and their cumulative anthropogenic effects on cetaceans in the South African Exclusive Economic Zone (EEZ) and South African Marine Protected Areas (MPA), Important Marine Mammal Areas (IMMA), Ecologically or Biologically Significant Areas (EBSA) and ecoregions. We determined cetacean species richness in these five area categories using ensemble models, and identified anthropogenic impacts from relevant literature. We calculated and compared the average species richness, the average trend for each stressor and average cumulative impact between 2003 and 2013 in the five areas. Results highlight that climate related stressors (such as sea surface temperature and ocean acidification), together with shipping stressors, are increasing more rapidly than other stressors across the EEZ. Cetacean species richness was highest along the west coast shelf and shelf edge where sea level rise, ocean acidification, shipping, and commercial pelagic fishing with low by-catch were most pronounced. The results of this study will inform marine spatial planners and policy makers in determining priority areas for cetacean conservation and in identifying anthropogenic stressors that need to be addressed to mitigate cumulative anthropogenic impacts on cetaceans.

SARS-CoV-2 Can Productively Infect Seal Epithelial Cells In Vivo, Underscoring the Need for Caution of Possible Reverse Zoonosis
Wendy Puryear1, Kaitlin Sawatzki2, Alexa Foss1, Inga Sidor3, Ashley Stokes4, Jonathan Runstaedler2
1Tufts, North Grafton, MA, 2Tufts University, Cummings School of Veterinary Medicine, North Grafton, Massachusetts, 3University of New Hampshire, Durham, New Hampshire, 4Seacoast Science Center, Rye, New Hampshire

In late 2019 the novel coronavirus severe acute respiratory coronavirus 2 (SARS-CoV-2) made the leap from an animal reservoir to the human population, rapidly circumnavigating the globe to become a major viral pandemic by early March 2020. Surveillance efforts by our lab and others have already shown evidence for potential reverse zoonoses into feline, canine, and mustelid, with additional susceptible species identified through experimental infection. To date, surveillance has not identified SARS-CoV-2 in marine mammals, though other members of the coronaviridae family are known to infect both cetaceans and pinnipeds, and modeling of the primary receptor ACE2 suggests that many marine mammals are predicted to be highly susceptible to SARS-CoV-2. Numerous studies have detected SARS-CoV-2 in wastewater and while the environmental stability of SARS-CoV-2 has yet to be elucidated, related coronaviruses are known to survive days to weeks in both fresh water and sea water. Given the coastal habitat of many marine mammals coupled with the...
presence of run off from human populations with the now nearly ubiquitous presence of SARS-CoV-2 around the globe, it is critical to understand marine mammal susceptibility to SARS-CoV-2 in order to make informed risk assessments and conservation decisions. We sought to determine if cells derived from seal tracheal epithelium were susceptible to infection by SARS-CoV-2. Cells were derived from a recently deceased wild-stranded juvenile gray seal undergoing necropsy. Immortalized epithelial cells exhibited extensive cytopathicity upon exposure to SARS-CoV-2/human/USA/WA-CDC-WA1/2020, and subsequent titrations demonstrated that the seal epithelial cells were productively infected and able to propagate virus. Further work is underway to assess susceptibility of cells derived from additional species, while also characterizing the viability of SARS-CoV-2 under varying environmental parameters.

Can Young People Be a Good Investment in Policy Change and Conservation? Combining Art and Science as a Communication tool
Barbara Putnam1, Luigi Bundone2, Hope Ronco3
1St. Mark's School, Southborough, MA, 2Archipelagos - ambiente e sviluppo, Italia, Venice, Italy, Italy, 3Protected Species Division / NOAA / PIFSC, Honolulu, HI

Rapidly developing technology and the urgency of climate change are pushing scientific research, expanding experimental possibilities and data collection ahead of stakeholders, state leaders, and the public who need to be engaged, included, and informed. Both scientists and artists see the urgency to effect change, to study species at the brink of extinction, and to make recommendations to the public. To change behavior that has an impact on sectors of the economy necessitates the expansion of a communication model that reaches the hearts and minds of policymakers. Bringing two fields to one allows the scientist to ask philosophical questions while the artist creates an emotional statement grounded in scientific fact. High school students following an art-studio course over two years were partnered with researchers working on the two existing monk seals species and their habitat, Hawaii and the Mediterranean Sea. The students learned about logistics, fieldwork, data gathering, and analysis. They asked questions to the scientists and focused their research. They were tasked with synthesizing images to construct a composition that could accurately speak to the scientific community and educate the public along with text summarizing their research with references. Resulting paintings and text show that the students broadened their access to the sciences at a critical age of exposure. The school community learned about the communicative power of art as the students’ paintings were exhibited in the school and presented in a workshop at the World Marine Mammal Conference, Barcelona, 2019. Students taking advanced courses continue to explore marine issues as a result of their initial exposure. Their paths cannot be predicted as they go to college but presenting the two disciplines as interdependent with access to field scientists amplifies the value of scientific literacy through persuasive visual communication, opening a cross-disciplinary approach to decision-making in multiple fields.

Spatial distribution and abundance of small cetaceans in the Pacific waters of Guatemala
Ester Quintana-Rizzo1, Andrea A. Cabrera Arreola2, Jennifer Ortiz-Wolford2, Vanessa Dávila2
1Simmons University, 2University of Copenhagen

The establishment of marine protected areas (MPAs) requires a thorough assessment of the abundance, distribution, and habitat preferences of a variety of marine species. These assessments are needed in Guatemala because a series of MPAs will be created. Boat surveys were
conducted for 38 months between January 2008 and June 2012 to study small cetacean spatial distribution and abundance in the local Pacific waters. A total of 64,678 cetaceans in 505 sightings from nine Delphinidae species were recorded. Three species accounted for 90% (n = 456) of all sightings. They included *Tursiops truncatus* (55%, n = 278), *Stenella attenuata* (28%, n = 143), and *S. longirostris* (7%, n = 35). Group size was significantly different among these three species (p < 0.001). *S. longirostris* had the largest group size (444 ± 75 dolphins), followed by *S. attenuata* (28 ± 5 dolphins), and *T. truncatus* (15 ± 2 dolphins). *T. truncatus* was the most common species in the study area (0.02 ± 0.002 sightings/km of survey effort). *S. attenuata* (0.37 ± 0.16 dolphins/km) and *S. longirostris* (1.62 ± 0.41 dolphins/km) were the most abundant species in the neritic (≤ 200 m depth) and oceanic zones (≥ 200 m depth), respectively. The wide-ranging distribution of *T. truncatus* overlapped with the distribution of *S. attenuata* in the neritic zone and of *S. longirostris* in the oceanic zone, but the distribution of the latter two species overlapped very little. No hotspots were detected near or in the MPAs. Most hotspots (~66%) were in the oceanic zone along the 200 m isobath, the Middle America trench, and the San José Canyon suggesting that these could be areas of high productivity. Our results suggest that the protection of small cetaceans needs to consider the creation of oceanic MPAs that should be integrated into the existing network.

**Consistent Space Use of Individual Dolphins is Associated with Blubber and Blood Pollutant Concentrations and Calving Success**

Alicia Quirin¹, Hannah Baker², Meghan Weinpress-Galipeau¹, Alex Douglas³, Patricia Fair⁴, David Lusseau⁵

¹School of Biological Sciences - University of Aberdeen, AIMM - Marine Environment Research Association, Ferreiras, Portugal, ²South Carolina Aquarium, Charleston, South Carolina, ³School of Biological Sciences, University of Aberdeen, Aberdeen, United Kingdom, ⁴Medical University of South Carolina, Charleston, SC, ⁵National Institute of Aquatic Resources, Technical University of Denmark, Kgs. Lyngby, Denmark

Persistent organic pollutants (POPs) are pervasive in the environment and pose conservation challenges because they may threaten population survival by affecting individual vital rates. Since space use can influence POP exposure, individual fine-scale habitat use within the same population has to be considered to make inferences about population cumulative exposure and threats. Here we determined whether individual bottlenose dolphins (*Tursiops truncatus*) in Charleston harbor (CHS, South Carolina) varied in their space use and whether any ranging heterogeneity could be related to concentrations of polychlorinated biphenyls (PCBs), chlorinated pesticides, polybrominated diphenyl ethers (PBDEs) and perfluorinated compounds (PFCs) sampled in health-assessed dolphins of the population. We estimated the ranging patterns of photo-identified individuals sampled from 2003-2009 using open spatially-explicit capture-recapture models. Regardless of sex, individuals had consistent ranging patterns, which did not extend over the whole harbor, meaning they consistently concentrated their activities in specific locations. We predicted the range of dolphins captured and released in 2003-2005 and 2013 in CHS health assessments. Given their age and sex, the legacy and emerging POP-load of those dolphins depended on their use of the harbor. Finally, we assessed whether calving success was associated with the locations mothers consistently used. We tracked 251 calf histories by identifying mothers with a newborn in one year and resighting the mother the next year. Calf survival probability over this first year was heterogenous across CHS. We accounted for spatial autocorrelation among contaminant and
calf survival variables using spatial simultaneous autoregressive linear models before assessing whether calf survival was associated with a contaminant. Mothers living in areas where dolphins tended to have larger pesticide loads tended to have lower calf survival. These analyses provide an avenue to use longitudinal data to assess potential population consequences of stressor exposure and detect regions of the study area that raise conservation concerns.

Deepwater Horizon Oil Spill Long-Term Impacts on Delphinids and Benthic Invertebrates in a Continental Shelf Ecosystem Using Unsupervised Clustering of Acoustic Records

Macey Rafter1, John Hildebrand2, Sean Wiggins3, Kait Frasier4
1Scripps Institution of Oceanography, University of California San Diego, San Diego, CA, 2Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA

The Gulf of Mexico (GOM) is characterized by a broad, shallow continental shelf habitat in which Atlantic spotted (Stenella frontalis) and bottlenose dolphins (Tursiops truncatus) are the predominant marine mammal species. Following the Deepwater Horizon (DWH) oil spill in 2010, impacts on marine mammals were studied in nearshore and deep water systems, but offshore shelf species have received little attention. In this shallow but pelagic habitat, delphinids range more broadly than their nearshore counterparts, but likely also have greater potential for chronic exposure to contaminated sediments and deposited oil than cetaceans found beyond the continental shelf in deeper waters. We describe delphinid and snapping shrimp acoustic occurrence recorded over a ten year period (2010-2020) at a shallow monitoring site (93 m) located on the Mississippi-Alabama Shelf, 60 miles north of the DWH wellhead. An unsupervised clustering approach was used to train a neural network to distinguish odontocete echolocation clicks, snapping shrimp signals and ship sounds with 92% accuracy verified manually by an analyst. Delphinids were detected at the site year round, with increased presence in summer. Occurrence in the summers of 2010 and 2011 may have been suppressed relative to later years. Snapping shrimp detections were near-constant initially, but began to gradually decline beginning in the summer of 2011 through the remainder of the monitoring period. Surface oil associated with the DWH slick was observed in the vicinity of this site for an estimated 50 days, with likely impacts including extensive flocculation of oiled algae (dirty blizzard), surface application of dispersants, and controlled burning. This study provides a unique opportunity to simultaneously observe interannual variability and long-term trends in the occurrence of a top mammalian predator and a benthic invertebrate as possible sentinels of ecosystem health.

Decadal-Scale Changes in Baleen Whale Distribution in the Central and North-East Atlantic

Nadya Ramirez-Martinez1, Gisli Vikingsson2, Nils Øien3, Bjarni Mikkelsen4, Thorvaldur Gunnlaugsson5, Philip Hammond6
1University of St Andrews (SMRU), University of Veterinary Medicine Hannover Foundation (ITAW), Fundacion Macuaticos Colombia, Bogota, Colombia, 2Marine and Freshwater Research Institute, Hafnarfjörður, Iceland, 3Bergen, Norway, 4Faroe Islands, 5Marine and Freshwater Research Institute, Reykjavik, Iceland, 6University of St Andrews, St Andrews, United Kingdom

In the central and north-eastern Atlantic fin, humpback and common minke whales are the most commonly found baleen whales. Some changes in their distribution have been observed coincident with changing oceanography of the North Atlantic in the last 30 years. We aimed to
improve understanding of the underlying ecological drivers of changes in these whales’ distribution, using data from series of summer surveys (in Iceland–Faroes and Norway, covering 6.9 million km$^2$) to model whale density as a function of relief, physical and biological oceanographic covariates using GAMs. The best models, based on a robust model selection framework, were used to predict distribution. The study period was divided into two periods, 1987-1989 and 1998-2015, based on environmental changes and data availability. In both periods depth and sea surface temperature were the common covariates that best explained these species’ distributions, indicating these are useful indirect proxies for prey. Fin whales were associated with deep waters and humpback whales were weakly associated with shallow waters. Minke whales overlapped to some extent with both species, being positively associated with deep waters $>3500$ m but also with shallow waters $\leq 300$ m. The dynamic environmental variables considered all showed summer relationships, supporting the hypothesis that the time lag between density and oceanographic covariates is short for species that feed low in the trophic web. The predicted distribution of all species showed higher density in more northerly areas including in the Barents Sea and north of Iceland; however, an exception is the predicted increase in fin whale density in the Irminger Sea. Overall, there was an expansion to a broader distribution, especially in new areas close to the limits with Arctic waters. This new knowledge helps to improve understanding of how these species may respond to a changing environment.

**Scale-dependent habitat selection of coastal bottlenose dolphins in a shallow tropical lagoon**

**Eric Angel Ramos**, Laura J. May-Collado, Marcelo Magnasco, Diana Reiss

1The Graduate Center, City University of New York, BROOKLYN, NY, 2University of Vermont, Burlington, VT, 3The Rockefeller University, New York, NY, 4Hunter College, New York, New York

Habitat selection is an active process. Optimal foraging theory predicts the patchy distribution of prey in heterogeneous landscapes drives predators to increase their search effort in prey-rich patches to maximize feeding opportunities. Determining associations between movement and activity patterns between feeding and non-feeding habitats can provide important insights into factors influencing predator habitat selection and the use of critical habitats. Here, we investigated fine-scale movement patterns and habitat selection preferences of bottlenose dolphins (*Tursiops truncatus*) inhabiting shallow lagoons at Turneffe Atoll in Belize. Previous studies reported that local dolphins preferentially feed in seagrass/sand boundary microhabitats and some of the resident population specialize in bottom foraging within dense seagrasses. We hypothesized dolphins display scale-dependent habitat selection preferences and activity-dependent movement patterns. We predicted dolphins would spend more time feeding in regions dominated by heterogeneous seagrass/sand boundary habitats than homogenous contiguous seagrass beds, display area-restricted search (ARS) behaviors while feeding within dense seagrasses, and show directional continuous movements during non-feeding behaviors. We conducted boat-based surveys from 2015–2017 to sight and photo-ID dolphins and film their behavior using a small multirotor drone. Aerial video observations, GPS flight tracks, and satellite imagery were used to generate trajectories of group movements per flight to compare spatial characteristics of path and activity patterns across classified habitat types. Dolphin showed differential activity and movement types across habitats, feeding almost exclusively in seagrass/sand boundary habitats in outer regions of the lagoon. First passage time analysis of group trajectories revealed intensively searched areas overlapped with ARS zones at fine spatial scales (5–45 m), closely matching the scales of their feeding behaviors and of dense
Predictor-prey interactions: modelling the multi-species functional response of grey and harbour seals in the North Sea
Janneke Ransijn¹, Philip Hammond², Langton Rebecca¹, Peter Wright³, Sophie Smout⁵
¹Leeuwarden, United Kingdom, ²University of St Andrews, St Andrews, United Kingdom, ³Marine Scotland Science, Aberdeen, United Kingdom, ⁴Marine Scotland Science, Aberdeen, United Kingdom, ⁵University of St Andrews, Sea Mammal Research Unit, St Andrews, United Kingdom

1) Resource uptake is the fundamental process that links trophic levels through predator-prey interactions. The critical component that describes how consumption rate of a predator varies in relation to prey density is the functional response and is crucial to understand trophic interactions, predation pressure, prey preference and population dynamics.

2) This study modelled the multi-species functional response (MSFR) of grey (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) in the North Sea to describe how consumption will vary dynamically depending on the availability of multiple prey species. Bayesian methodology was employed to estimate MSFR parameters and to incorporate uncertainties in diet and prey

Effects of Duty Cycles on the Passive Acoustic Monitoring of Southern Resident Killer Whale (*Orcinus orca*) Occurrence and Behavior
Zoe Rand¹, Jason Wood², Julie N. Oswald³
¹University of Washington, Seattle, WA, ²SMRU Consulting, Friday Harbor, WA, ³University of St. Andrews, St Andrews, Fife, Fife, United Kingdom

Long-term passive acoustic monitoring of cetaceans is frequently limited by the data storage capacity and battery life of the recording system. Duty cycling is a mechanism for subsampling during the recording process to facilitate long-term passive acoustic studies. There has been little investigation on the impact of duty cycling on the ability to answer questions about a species’ behavior and occurrence. In this study, we investigated the effect of duty cycling on the acoustic detection of Southern Resident killer whales (*Orcinus orca*). Continuous acoustic data were subsampled to simulate 288 duty-cycled datasets with cycle lengths from 5 to 180 minutes and listening proportions from 0.1 to 0.67. Duty cycles had little effect on the detection of daily presence of SRKW. However, duty cycles did impact investigations requiring fine-scale acoustic behavior. We found that to accurately detect hourly SRKW presence, cycle lengths of less than an hour were required. Additionally, a statistically significant (one-way ANOVA, p <0.05) diel pattern in SRKW acoustic behavior was found in 23 of the 288 duty cycled datasets tested (8%), whereas no diel pattern was evident in the continuous data. Additionally, in duty cycled datasets with listening proportions of less than 0.2 and cycle lengths greater than 60 minutes, a greater number of acoustic bouts were found, and the median length of bouts were underestimated compared to the continuous data. Finally, the ability to identify acoustic bouts to ecotype decreased with decreasing cycle lengths and listening proportions, as shorter recording times led to the detection of fewer stereotyped calls. Based on our results, we conclude that the optimal duty cycle for passive acoustic studies of SRKWs requires cycle lengths of 30-60 minutes and listening proportions of 0.4-0.67. Additionally, this study provides a framework for a quantitative analysis of optimal duty cycles for other marine species.
availability estimates. Diet composition was based on information from seal faecal samples. Prey availability estimation was based on combining prey distributions, estimated from fish survey data, with predictions of the geographical area that was accessible to the predator, given food passage time, from telemetry data.

3) Results indicated that both seal species have a type III functional response. Sandeels are important but more strongly preferred by grey seals. While harbour and grey seals are sympatric and consume similar prey species, results also suggested that they might be functionally distinct predators, with harbour seals having a more diverse diet and exhibiting a more sigmoidal response that may indicate a greater tendency to switch prey. Depending on what kind of prey is available and their associated profitability (i.e. obtained energy divided by costs of acquiring that prey) could lead to circumstances that are unfavourable for harbour seal populations.

From Russia with Love: A new mammalian sighting record highlights atypical transpacific breeding behaviour in humpback whales (Megaptera novaeangliae)
Nicola Ransome1, Olga Titova2, Olga Filatova3, Marie Hill4, Astrid Frisch5, Ted Cheeseman5, Jorge Urban7, Amanda Bradford8, Luis Medrano González9, John Calambokidis10, Pamela Martinez Loustalot11, Joshua Smith12
1Murdoch University, 2Kamchatka Branch of Pacific Institute of Geography DVO RAS, Petropavlovsk-Kamchatsky, Russia, Russia, 3Moscow State University, M, Russian Federation, 4CIMAR/PIFSC/NOAA, Honolulu, HI, 5Ecología y Conservación de Ballenas, ECOBAC, Puerto Vallarta, Jalisco, Mexico, 6Southern Cross University, 7Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico, 8Pacific Islands Fisheries Science Center, NOAA Fisheries, Honolulu, Hawaii, 9Universidad Nacional Autónoma de México, Mexico, 10Cascadia Research Collective, Olympia, 11Universidad Autonoma de Baja California

Understanding animal migratory behaviour is essential for effective species management. Variation in movement patterns within populations, may have profound implications on dynamics estimates and necessary policy for protection and conservation. This is especially true for large whale populations, such as the North Pacific humpback whale (Megaptera novaeangliae), that migrate through multiple countries’ jurisdictional waters. Several decades of research in the North Pacific have revealed a basic pattern of seasonal movements. Humpback whale migrations between low-latitude breeding and high-latitude feeding areas, are generally separated into the western, central and eastern ocean basin, with apparent strong site fidelity. However, genetic studies, mid-oceanic singing, unexpected migratory movements, and regional low recaptures rates suggest that something more complex is also occurring. Research in lesser-studied areas and greater collaboration facilitated by the online fluke-matching platform HappyWhale, have revealed a much higher number of individuals undergoing larger scale migrations across the North Pacific. Here we report on a new large whale long-distance sighting record; a humpback whale known to feed in Russia, which was sighted in subsequent years in the breeding areas of the Mariana Islands (2017) and Mexico (2018). With at least 11,246km between sightings, this is the longest recorded one-way movement of a mammal. We further investigated the unexpected presence of Russian whales in Mexico and found 113 uniquely identified individuals, sighted between 1998 and 2021. Many of these whales were seen in Mexico in multiple seasons (n=37, 32.74%, 2 – 9 years). However, there was a higher-than-expected interchange with other breeding areas (n=8, 7.08%). Sporadic sighting histories and low intra-seasonal recaptures in Mexico (whales without dependent-calves seen twice in a season, n=5, 4.42%), suggests short breeding ground
residency and/or constant travel. We explore several explanations as to why whales regularly cross an ocean basin to breed, but apparently spend little time on breeding area.

**Habitat-based Density Models for Common Bottlenose Dolphins (Tursiops truncatus) and Atlantic Spotted Dolphins (Stenella frontalis) in the Northern Gulf of Mexico**

Gina Rappucci¹, Lance Garrison², Joel Ortega-Ortiz³, Kevin Barry³, Keith Mullin¹, Laura Aichinger Dias⁵, Jenny Litz⁶

¹Cooperative Institute for Marine and Atmospheric Studies, University of Miami, Hallandale, Florida, ²Miami, FL, ³University of Miami, Cooperative Institute for Marine & Atmospheric Studies, Miami, Florida, ⁴NOAA Fisheries Southeast Fisheries Science Center, Pascagoula, MS, ⁵CIMAS/UM, NOAA/SEFSC, Miami, Florida, ⁶Marine Mammal and Turtle Division, SEFSC, NOAA Fisheries, Miami, Florida

As part of the Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS), we conducted aerial line-transect surveys of continental shelf waters of the U.S. Gulf of Mexico (GoMx) designed for marine mammal abundance estimation and development of spatial density models. Surveys were flown in the summer of 2017, winter of 2018, and fall of 2018 covering waters from the shoreline to the 200m isobath between Florida and Texas. Mark-recapture distance sampling methods employing the independent observer approach were used to estimate detection probability within the survey strip and account for perception bias. The primary marine mammal species observed over the continental shelf were common bottlenose dolphins (*Tursiops truncatus*) and Atlantic spotted dolphins (*Stenella frontalis*). Comparison of seasonally averaged abundance estimates for these species with similar surveys conducted during 2011-2012 generally indicated increased abundance between the two survey periods.

Spatial density models indicate that bottlenose dolphin density was highest in nearshore coastal waters and the inner portion of the continental shelf, while Atlantic spotted dolphins generally occurred in deeper waters of the outer shelf. The densities of both species were correlated with environmental covariates including depth, surface temperature, and surface chlorophyll concentrations and showed seasonal variability in spatial distribution. Regional patterns in spatial distribution are evident, and in particular there are differences in the onshore-offshore distribution of both species between the eastern and western GoMx. These models are an important tool for conservation and management in the GoMx, particularly in light of future development of aquaculture, renewable energy, sediment diversion, and restoration projects related to impacts from the Deepwater Horizon oil spill.

**Characterizing the Nursing Behavior by Video and 3D-Accelerometry in Humpback Whales off Sainte Marie Channel, Madagascar**

Maevatiana Nokoloina RATSIMBAZAFINDRANAHAKA⁴, Chloé Huetz², Olivier Adam³, Anjara Saloma⁴, Isabelle Charrier²

¹Université Paris-Saclay, Orsay, France, France, ²Université Paris-Saclay, Université Paris-Sud, CNRS, Institut des Neurosciences Paris-Saclay, 91405 Orsay, France, Orsay, France, France, ³Sorbonne Université, CNRS, Institut Jean Le Rond d’Alembert, F-75005 Paris, France, Paris, France, France, ⁴Cétamada, Sainte Marie, Madagascar

For the humpback whale, milk is the only source of energy for the calf during its first six months of life. It ensures its rapid growth, allowing it to start its first migration to feeding grounds alongside its mother. Despite its importance, nursing behavior has been poorly documented as difficult to observe with certainty. Three calves
accompanies of their mother were equipped with CATS cam tags (depth sensor, 3D accelerometer, 3D gyroscope, video camera, hydrophone) in the Sainte Marie channel, Madagascar, during the breeding season. A total of 10.5 h of video recording was obtained and analyzed manually. An analysis of the depth and 3D acceleration data was also performed allowing us to extract the pitch, roll, depth rate (DR), speed, tailbeat frequency (TBF), roll rate, and overall body dynamic acceleration (ODBA). We determined that nursing events lasted 18.75±8.75 s (n = 34) on average and were performed between 2 m and 32.6 m depth. The majority (30/34) constituted a sequence of 2-6 successive events spaced less than a minute apart. In total, nursing events represented 1.68% of the total observation time. While calves were seen at a 30°-45° angle relative to their mother during nursing, the recorded pitch indicated a body posture fairly close to the horizontal. In contrast, the recorded roll deviated from zero. Nursing events were characterized by a low DR, low speed and low roll rate, high FSR, and high ODBA compared to non-nursing bouts. The characterization of nursing behavior and the identification of its signature by accelerometry is a crucial step for developing automated detection methods. This will allow researchers to not depend on visual observations to accurately study this vital behavior. Indeed, a large number of multi-sensor tags are not equipped with a video camera and video recordings at night remain so far unusable.

Success! The first satellite flipper tag deployments on Steller sea lions (Eumetopias jubatus) allow tracking beyond the annual molt

Kimberly Raum-Suryan1, Lauri Jemison2, Michael Rehberg3, Kate Savage4
1Protected Resources Division, NMFS, NOAA Fisheries, JUNEAU, AK, 2Alaska Dept of Fish and Game, Anchorage, 3Alaska Department of Fish and Game, Division of Wildlife Conservation, Marine Mammal Section, Anchorage, AK, 4NOAA Fisheries Juneau Protected Resources Office, Juneau, AK

Advances in remote sedation now allow us to safely capture adult Steller sea lions (SSLs; Eumatopias jubatus) even if they go into the water. To track SSLs once they are released, we have traditionally attached satellite tags to the SSL’s hair via adhesive epoxy. Unfortunately, deployment time was limited with this method because tags fell off during the late summer molting period. To overcome this problem, we tested Wildlife Computers, Inc. SPOT 6 Model 371B Argos location-only transmitters (tags) mounted on SSL foreflippers using two attachment posts. These tags were designed for ice-obligate phocids so we took several steps prior to first-time deployment on otariids. Because we found limited information about otariid flipper vasculature, we dissected a SSL carcass flipper to locate major and minor blood vessels and nerves to ensure tag placement would not interfere with them. We then tested flipper tag attachment techniques on a SSL carcass to determine best tag placement, orientation, and tools for attachment. Because previous experience indicated these tags, designed for ice seals, might deplete their batteries on non-ice substrates, we tested the tags, in cooperation with Wildlife Computers, Inc. on a SSL carcass lying on a rocky beach using various orientations and distances from the water’s edge. From 2018-2019 we successfully deployed tags on six live subadult/adult male SSLs in Southeast Alaska as part of entanglement response and research studies. Tags provided SSL haulout locations with a median duration of 205 days (range: 68-500 days). Following this success, in 2019 we deployed seven tags on endangered adult female SSLs in the Gulf of Alaska with even greater deployment success (median duration = 470 days; range: 160-540 days). Results demonstrate that for the first time, flipper-mounted SPOT tags now can be used to track SSL haulout locations year-round, despite the molt.
Vocal plasticity in harbour seal pups
Laura Torres Borda¹, Yannick Jadoul², Heikki Rasilo², Anna Salazar Casals¹, Andrea Ravignani²
¹Sealcentre Pieterburen, Pieterburen, Groningen, Netherlands, ²Comparative Bioacoustics Group, Max Planck Institute for Psycholinguistics, Nijmegen, Netherlands

Vocal plasticity can occur in response to environmental and biological factors, including conspecifics’ vocalisations and noise. Pinnipeds are one of the few mammalian groups capable of vocal learning, and are therefore relevant to understanding the evolution of vocal plasticity in humans and other animals. Here, we investigate the vocal plasticity of harbour seals (*Phoca vitulina*), a species with vocal learning abilities attested in adulthood but not puppyhood. To zoom into early mammalian vocal development, we tested 1-3 weeks old seal pups. We tailored noise playbacks to this species and age to induce seal pups to shift their fundamental frequency (F0), rather than adapt call amplitude or temporal characteristics. We exposed individual pups to bandpass-filtered noise, which purposely spanned – and masked – their typical range of F0s, and simultaneously recorded pups’ spontaneous calls. Seals were able to modify their vocalisations quite unlike most mammals: They lowered their F0 in response to increased noise. This modulation was punctual and adapted to the particular noise condition. In addition, higher noise induced less dispersion around the mean F0, suggesting that pups may have been actively focusing their phonatory efforts to target lower frequencies. Noise masking did not seem to affect call amplitude. However, one seal showed two characteristics of the Lombard effect known for human speech in noise: significant increase in call amplitude and flattening of spectral tilt. Our relatively low noise levels may have favoured F0 shifts while inhibiting amplitude adjustments. This lowering of F0 is quite unusual, as other animals commonly display no F0 shift independently of noise amplitude. Our data represents a relatively rare case in mammalian neonates, and may have implications for the evolution of vocal plasticity across species, including humans.

Mercury Rising: Significant Within-decade Increase in Mercury Concentrations in Steller Sea Lion Pups at Agattu Island, Alaska
Lorrie Rea¹, Stephanie Crawford², J Margaret Castellini³, Julie Avery³, Brian Fadely³, Mandy Keogh¹, Michael Rehberg¹, Todd O’Hara⁶
¹University of Alaska Fairbanks, Fairbanks, Alaska, ²University of Alaska Fairbanks, Fairbanks, Alaska, ³NMFS/AFSC Marine Mammal Laboratory, Seattle, Washington, ⁴NOAA Alaska Region, Juneau, AK, ⁵Alaska Department of Fish and Game, Division of Wildlife Conservation, Marine Mammal Section, Anchorage, AK, ⁶University of Alaska Fairbanks, Fairbanks, AK

Although many Steller sea lion (*Eumetopias jubatus*) metapopulations within the endangered western Distinct Population Segment have stabilized or begun to recover after a dramatic population decline in the 1970-90’s, some rookeries in the western and central Aleutian Islands continue to decline. We documented higher median total mercury concentrations ([THg]) in lanugo (natal fur) of young pups on rookeries that continue to decline in population and that show lower total selenium (TSe) to THg molar ratios in pup blood. As an essential antioxidant and modulator of Hg toxicosis it is important to interpret THg relative to TSe. As lanugo is grown *in utero*, this relates to pup exposure to Hg during fetal development when methylated forms have the greatest potential for neurotoxicosis. We found a broad range of [THg] (2.55–73.74 µg/g dw) in lanugo samples from pups sampled at Agattu Island in June of 2011, 2012, 2013, 2015, 2017, 2018 and 2019 (n=339). We identified a significant increase in median [THg] in the lanugo of pups over this brief period.
from 8.005 µg/g in 2011 to 17.275 µg/g in 2019 (Kruskal-Wallis H=41.24, p<0.001). The proportion of pups sampled on Agattu Island with lanugo [THg] above 20 µg/g THg (a published threshold of adverse effect of mercury in pinnipeds) increased more than twofold during this time period from 20.6% in 2011 to 46.4% in 2019. This proportion of pups at high risk for adverse effect consistently increased at a rate of 3.7% per year. These biologically significant increases in [THg] accumulated through maternal diet are particularly concerning due to the short, intra-decadal scale of the escalation and consistent rate of increase of proportion of pups at risk.

Capturing fisher’s knowledge: fishing activity, experience and socio-economic impacts of marine animal entanglements to the Scottish creel fishery
Fiona Read, Whale and Dolphin Conservation

Entanglement in fishing gear is the most prevalent anthropogenic threat to cetacean welfare and conservation but is poorly understood. Interviews with 159 Scottish commercial creel fishers were conducted to find out about their experiences of marine animal entanglement over a 10-year period between 2008-2018. Almost half of fishers had experienced at least one entanglement in the last ten years. 146 marine animal entanglements involving at least 12 different species were reported during the interviews, including several small cetaceans. The main species reported entangled were minke whale and basking shark. Over 70% of recorded entanglements were found dead in the gear. All dolphin and porpoise species reported were found entangled in endlines. Minke whales and basking sharks were more often found entangled in groundlines and humpbacks were found in both groundlines and endlines. Entanglements occurred all around the coast, although more entanglements of all species were reported along the west coast and around the Northern Isles than on the east coast. Factors which appeared to be influential in entanglement risk were fishing depth, gear length, hauling frequency and target species. The average cost of each entanglement event was estimated to be £830 (approx. 1180 USD), however fishers said their main concern was the welfare of the animal. The majority of fishers suggested theoretical measures that they felt could prevent or reduce the risk of entanglement and 75% expressed willingness to test mitigation measures. Only 3 entanglements were previously known to the stranding network emphasising the significant underreporting of these events. Entanglements are a rare event for individual fishers and for most entanglement was a single event, however cumulatively entanglements pose a significant welfare and conservation issue for species such as minke and humpback whales in Scottish waters. The project demonstrates a positive collaboration between the fishing industry, research and conservation organisations.

Temporal patterns of downsweep and SEP calls in Chilean blue whales (Balaenoptera musculus)
Laura Redaelli¹, Sari Mangia Woods², Rafaela Landea³, Laela Sayigh⁴
¹University of Groningen, Merate, ²University of Groningen, ³Santiago, Chile, ⁴Woods Hole Oceanographic Institution/Hampshire College, Woods Hole, Massachusetts

In an effort to learn more about occurrence and behaviour of blue whales in the Chiloense ecoregion of southern Chile, passive acoustic data were collected for 15 consecutive months (January 2012 – April 2013) with Marine Autonomous Recording Units (MARUs). Automatic detectors and manual auditing were used to detect blue whale songs (SEP calls) and downsweep calls (D calls), which were then analysed to gain insights into temporal calling
patterns. Blue whale D calls occurred year-round, with the majority occurring during austral summer (December to April), peaking in February. SEP calls, in contrast, only occurred between December and June, peaking in April. Thus, although our results support previous studies documenting austral summer residency of blue whales in this area, they suggest that at least some individuals remain year-round. We also investigated daily occurrence of each call type: D calls occurred more frequently during twilight hours (dawn and dusk) compared to day and night periods, whereas SEP calls did not show any diel patterns. These temporal differences, both seasonal and diel, likely relate to differences in call function. SEP song is believed to function as a reproductive display, whereas D calls are believed to be involved in feeding behavior. Our results may lead to the development and testing of more specific hypotheses regarding the role D calls may play in blue whale feeding behavior. Overall, our findings contribute to a better understanding of seasonal and diel trends of Chilean blue whales, which can in turn enhance our ability to develop conservation strategies toward preserving this endangered population in one of the most important coastal feeding grounds of the southern hemisphere.

Listening to mothers: modeling the true reproductive states of individual female right whales provides new insights into their decline

Joshua Reed1, Leslie New2, Peter Corkeron1, Rob Harcourt1
1Macquarie University, Bella Vista, NSW, Australia, 2Washington State University, Vancouver, WA, 3New England Aquarium, Boston, Massachusetts, 4Macquarie University, Sydney

North Atlantic right whales (Eubalaena glacialis, NARW) abundance, and the temporal trends thereof, have traditionally been estimated using mark-recapture analyses with an underlying stage-structured population, where an individual’s status is imposed based upon an arbitrary age. Here we assigned individuals based upon their reproductive experience, rather than age. We developed a Bayesian mark-recapture-recovery model to investigate how survival, recapture, fidelity and recapture probabilities vary for female NARW for different reproductive classes, using data collected from 1977-2018. Reproductive classes were assigned as calves, for individuals in first year; pre-breeder for individuals greater than one year of age who have yet to produce a calf, or breeder based upon if an individual has reproduced. A decline in the abundance of female NARW was seen following 2010 where an estimated 185 females declined yearly to 142 in 2018. The largest decline was seen in breeding females, with only 72 estimated to be alive at the beginning of 2018, while the abundance of pre-breeding females plateaued at around 70 between 2011 and 2018. This delay in age of first reproduction for the current cohort of young females resulted in breeding females making up just 51% of the female population by 2018. Our analysis shows that not only a concomitant collapse in the fecundity of breeding females, but the failure of pre-breeders to recruit to breeders, is driving this population decline.

Whistle characterization and repertoire comparison of coastal and offshore pantropical spotted dolphins in the eastern tropical pacific

Manali Rege-Colt1, Julie N. Oswald2, Joëlle De Weerdt2, Jose David Palacios-Alfaro4, Maia Austin4, Emma Gagne1, Laura J. May-Collado1
1University of Vermont, Burlington, VT, 2University of St. Andrews, St Andrews, Fife, Fife, United Kingdom, 3Association ELI-S, Gujan-Mestras, France, 4Independent reseacher, San Jose, Costa Rica

There is currently no published work focusing on the acoustic communication of the coastal pantropical spotted dolphin (Stenella attenuata graffmani). Toothed whales produce
communicative signals called whistles that are crucial for group coordination, recruitment, and individual recognition. We present the first characterization and repertoire diversity assessment of coastal pantropical spotted dolphin whistles in comparison with the offshore ecotype using traditional and novel methods. Acoustic recordings of the coastal subspecies were obtained from research surveys using over-the-side hydrophones in the Pacific coastal waters of Nicaragua and El Salvador. Recordings of the offshore ecotype were collected during NOAA cetacean abundance research cruises in the Eastern Tropical Pacific using towed hydrophone arrays. Frequency and time measurements were taken from 657 coastal and 652 offshore high quality whistles to determine whistle acoustic structure. Clustering analysis of the fundamental frequency contours revealed large overlap in ecotype repertoire. Random forest classification performed with an accuracy of 83.99% and k=0.68 and identified duration and peak frequency variables as the most informative in distinguishing between ecotypes. Lastly, fundamental frequency contours were extracted and categorized using an unsupervised neural network to assess the diversity of the coastal and offshore ecotype whistle contour repertoires. Estimates of repertoire richness and diversity provided evidence that the offshore ecotype repertoire is more diverse and the ecotype repertoires differ in their composition. This study documents the first detailed description of the coastal ecotype’s whistles and finds that the ecotypes of pantropical spotted dolphins in the Eastern Tropical Pacific have whistle repertoires that vary in frequency and duration, size, and diversity, agreeing with previous genetic and morphological ecotype distinction.

Thar She Blows! Nasal Plug Anatomy Determines Blow Shape
Joy S. Reidenberg, Ph.D.1, Eric Angel Ramos2, Brianna Francis3, Maria Maust-Mohl4
1Icahn School of Medicine at Mount Sinai, New York, New York, 2The Graduate Center, City University of New York, BROOKLYN, NY, 3New York, New York, 4Manhattan College

Blowholes are adapted for efficient breathing at the surface, protection from water incursions, and efficient evacuation of a large volume of air in a short period of time. Blowhole opening occurs when muscles contract to shift the nasal plugs forward (rostrally), while closure occurs when the muscles relax and the nasal plugs recoil back into the nasal cavity. Movement or shape changes of the plugs is hypothesized to enable pressure equilibration of the air-filled nasal cavities during diving/ascent. The mechanisms that widen the nasal lumen or generate specific exhalation blow patterns are not understood. The nasal region (blowholes, upper nasal passages, nasal plugs) was dissected in six specimens from three species of rorquals: fin (Balaenoptera physalus), minke (B. acutorostrata), and humpback (Megaptera novaeangliae) whales. Magnetic Resonance Images were used to generate high-resolution two- and three-dimensional reconstructions of an adult minke’s nasal tissue. Results indicate nasal plug structure and composition are similar, but with species-specific size and shape variations. Fins have relatively small plugs with rounded tips. Minkes have the smallest relative sized plugs with pointy tips. Humpbacks have the largest relative sized plugs with rounded tips. All plugs were anchored medially along the cartilaginous nasal septum that limits plug excursions. Internal structure is comprised of fat interlaced with skeletal muscle. Muscle fiber directions indicate a potential to curl the tip, but with limited shape-changing properties. Rather, medial anchoring likely contributes to deforming the plug shape. The plug is stretched when withdrawn rostrally from the anchor, causing flattening against the curvature of the bony nasal wall. This would allow a larger lumen for airflow, but the contours of the plug appear to direct air in a spiral path around the tissue. The spiraling geometry is species-specific, and likely contributes to the
unique blow shapes observed in exhalation for different species.

**Quantitative fatty acid signature analysis (QFASA) validated for killer whales reveals differences in diets-compositions across the North Atlantic**

Anais Remili¹, Rune Dietz², Christian Sonne², Filipa Samarra³, Audun Rikardsen¹, Lisa Kettener¹, Steven Ferguson⁶, Cortney Watt⁶, Cory Matthews⁶, Jeremy Kiszka⁷, Eve Jourdain⁸, Katrine Borgå⁹, Haley Land-Miller¹⁰, Adam Pedersen¹¹, Melissa McKinney¹¹¹

¹McGill University / Whale Scientists, Sainte Anne de Bellevue, Quebec, ²Aarhus University, Roskilde, Denmark, ³University of Iceland, Vestmannaeyjar, Iceland, ⁴The Arctic University of Norway- UiT, Tromsø, Norway, ⁵Tromsø, Norway, ⁶Fisheries and Oceans Canada, Winnipeg, Manitoba, ⁷Florida International University, North Miami, Florida, ⁸Norwegian Orca Survey, Andenes, Norway, Norway, ⁹University of Oslo, Oslo, Norway, ¹⁰McGill University, Sainte Anne de Bellevue, Quebec, ¹¹McGill University, Ste-Anne-de-Bellevue, QC

The feeding ecology of killer whales (Orcinus orca) across ocean regions remains uncertain, despite decades of research on different populations. Accurate diet estimates are critical for these apex predators, as they top-down regulate food webs. To date, no study has assessed the diet composition among and within populations across the 5,000 km span of the North Atlantic (NA). Quantitative fatty acid (FA) signature analysis (QFASA) offers the potential to quantitatively estimate diet compositions of killer whales but requires calibration coefficients (CCs) accounting for predator metabolism. We developed and validated QFASA for killer whales using full-depth blubber biopsies from captive individuals fed a known diet and then used this approach to estimate the diets of free-ranging killer whales across the NA. As FA profiles are stratified across the blubber depth, and typically only outer blubber (dart) biopsies are available for free-ranging cetaceans, we computed full, outer, and inner blubber CCs using depth-specific FA signatures of the captive killer whales and FA signatures of their long-term diet items. Accurate diet estimates (83% average accuracy) for these individuals were achieved using blubber-layer-specific CCs. We then modeled diets of free-ranging NA killer whales using the appropriate CCs (n=157). Diet estimates were spatially variable, with Canadian killer whales consuming mainly cetaceans, Greenlandic killer whales consuming mainly pinnipeds, and Icelandic and Norwegian populations consuming a mixture of fish and marine mammals. These diet estimates were consistent with limited stomach contents analyses, field observation, and/or stable isotope patterns for some of the killer whales. Diet estimates also varied among individuals within a region. This newly developed cetacean-specific QFASA method can provide species-level diet estimates even from superficial dart biopsies and offers promise to quantify the feeding habits of killer whales in the NA and throughout the world’s ocean regions.

**Case Report: Interaction with Plastic Bottle Band in the Rostrum of Franciscana Dolphin (Pontoporia blainvillei) on the Coast of São Paulo**

Vanessa Ribeiro¹, Priscilla Maracini², Isabella Cristina da Rocha Boaventura³, Juarez Cabral³, Camila Brandão Seabra³, Victor dos Santos Luiz³, Italo Rafael Biní³, Ellen Mendes Marchiori³, Rodrigo Valle⁴, Carolina Bertozzi⁴

¹Instituto Biopesca, Praia Grande, São Paulo (SP), Brazil, ²Biopesca Institute, Praia Grande, São Paulo, Brazil, ³Biopesca Institute, Praia Grande, São Paulo (SP), Brazil, ⁴Biopesca Institute, Paulista University, Santos, São Paulo, Brazil, ⁵UNESP, São Vicente, São Paulo, Brazil

The Franciscana dolphin (Pontoporia blainvillei) is a small odontocete endemic to the east coast of
South America, qualified as Vulnerable in Red List (IUCN), with potential levels of mortality in gillnet fisheries (bycatch), impacted by marine debris and other forms of habitat degradation. Plastic debris affects marine mammal worldwide, mainly ingestion and entanglement. This case describes a necroscopic examination of a Franciscana dolphin caught accidentally in a gillnet, interacting with a plastic bottle band on the rostrum. The carcass was collected in the municipality of Praia Grande, São Paulo, Brazil, by the Biopesca Institute, which has been monitoring accidental catches in the region since 1998. The carcass collected was fresh, male, with a total length of 111.2 cm, evaluated as an adult for the FMA II (Franciscan Management Area) population. On external examination, the body score was cachectic, there were isopods on the body, linear gill marks on pectoral, dorsal, caudal fins, and rostrum; linear scarred marks on the flanks, in addition, the presence of a blue plastic band at the base of the rostrum, causing total constriction of the oral cavity. The 0.5 cm wide and 3.2 cm diameter seal was designed by cutting, as it did not even allow its movement due to adherence. Below this, ulcerative lesion of the dermis, absence of epidermis and rounded edges of the lesion in an inflammatory process, indicating a chronic character. He presented lungs with edema and congestion, multifocal nodules, moderate to severe, in the left lobe; heart with a focal nodule; stomach with generalized gastritis. The animal died due to accidental capture, but the presence of the plastic band and the cachectic body score of the animal, in addition to granulomatous pneumonia and pericarditis indicates an extreme weakness of the specimen, which would probably die due to starvation.

Manatees are exposed to watercraft, aircraft and road noise on Florida’s Atlantic coast
Julia Ribeiro Guimaraes Dombroski\textsuperscript{1}, Susan E Parks\textsuperscript{2}, Monica Ross\textsuperscript{3}, Mark Johnson\textsuperscript{4}
\textsuperscript{1}Syracuse University, Brazil, \textsuperscript{2}Syracuse University, Syracuse, New York, \textsuperscript{3}Clearwater Marine Aquarium Research Institute, Green Cove Springs, Florida, \textsuperscript{4}Aarhus Institute of Advanced Studies, Aarhus University, Denmark

Underwater noise from human activities may have important cumulative impacts on marine mammals, making it imperative to quantify exposure rates to individual animals. Studies of underwater noise exposure and impact have focused primarily on ubiquitous or intense sources such as shipping, oil exploration and naval sonar. However, coastal species may experience a wide variety of noise sources for which the potential impacts are unknown. In particular, although airborne sounds, such as aircraft and road vehicle noise, have been reported to contribute to marine soundscapes, individual exposure rates have seldom been measured. To quantify the exposure rates of anthropogenic noise on manatees, we deployed long-term sound and motion tags (DTAGs) on three manatees released off Florida’s Atlantic coast. DTAGs were integrated into GPS tracking gear and were set to continuously record for up to 48 days at 32kHz. Long-term spectral averages (LTSA, 200Hz/1s resolution) were inspected for anthropogenic noise exposure events and the likely source of each exposure was assessed by expert listening. As expected, small recreational watercrafts such as motorized boats and jet skis were frequently detected in the acoustic recordings. Exposure to watercraft varied temporally and spatially and ranged from 0 to 14 passing watercrafts/hour. More surprisingly, manatees were exposed to intense airborne sounds. Aircraft noise (airplanes and helicopters) were detected in recordings from all individuals and reached an average of 48 aircraft passes/hour in some periods. For one individual, siren sounds were detected suggesting exposure to road noise in areas of the manatee habitat. Our results suggest that airborne anthropogenic sounds can be an important component of noise exposure budgets for coastal species and warrant consideration when assessing the impact of noise.
Improving Ejaculate Quality for Conservation: Development of a Novel Artificial Vagina
Jacqueline Rich¹, Jonathan Cowart¹, Dara Orbach¹
¹Texas A&M University Corpus Christi, Corpus Christi, Texas, ²University of Florida, ³Texas A&M University- Corpus Christi, Corpus Christi, Texas

Cetaceans possess complex genital morphologies, which appear to coevolve between the sexes. Vaginal morphology may play an important role in mechanical stimulation of the penis during copulation and thus give stimulatory cues to the male that may help to improve overall ejaculate quality. Utilizing post-mortem common bottlenose dolphin (Tursiops truncatus) reproductive tracts to make digital models, we developed the first artificial vagina (AV) that mimics the natural shape of the dolphin vagina for use in voluntary semen collection from dolphins in managed care facilities. Because of the natural shape, we hypothesize that ejaculates collected using the AV will have improved sperm motility and integrity characteristics compared with manual stimulation. For this study, we compared ejaculates collected from dolphins using manual stimulation and with the use of the AVs. The behavioral, kinematic, and physical properties of sperm were evaluated using a computer-assisted sperm analysis (CASA) software. Two different CASA softwares were used and semen qualities were compared to assess the accuracy of results. Physical properties of sperm were analyzed using formalin-fixed aliquots of sperm subjected to various histochemical staining techniques, including: eosin nigrosin stain, Coomassie blue stain, toluidine blue stain, aniline blue stain, and eosin stain. We present preliminary data providing evidence that species-specific AVs improve ejaculate quality in bottlenose dolphins. This carries significant implications for the conservation of endangered species by shifting the focus of assisted reproductive technologies to the improvement of semen quality at the time of collection.

Evidence of Large Whale Socio-Sexual Behavior in the New York Bight
Meghan Rickard¹, Kate Lomac-MacNair², Ann Zoidis³, Darren Ireland⁴, Mitch Poster⁵, Sarah Leiter⁶
¹New York Natural Heritage Program; New York State Department of Environmental Conservation, Mount Sinai, NY, ²CCMAR, Universidade do Algarve, Fritz Creek, Alaska, ³Tetra Tech/ Cetos Research Organization / Allied Whale, Bar Harbor, Maine, ⁴LGL Ecological Research Associates, Bozeman, Montana, ⁵Tetra Tech, Inc., Oakland, California

Large whale species, including sei whales (Balaenoptera borealis), sperm whales (Physeter macrocephalus) and North Atlantic right whales (Eubalaena glacialis), are known to occur year-round in the New York Bight. However, relatively little data exists on the social behavior typical of these endangered species. Additionally, the U.S. mid-Atlantic has historically been considered a migratory corridor, with few surveys documenting the social dynamics of whale presence. To better understand the occurrence, distribution, abundance, and behavior of these species for management and conservation planning, monthly line-transect aerial surveys were conducted over a three-year period from March 2017 through February 2020. Three noteworthy socio-sexual behavior sightings were observed and photographed: a group of six sei whales in April 2019, a group of five sperm whales in September 2019, and a group of two right whales in December 2019. Events included what could be either non-reproductive sexual behavior (socio-
sexual behavior) or sexual behavior (copulation) among conspecifics, including mirror pair swim, lateral and vertical presenting, and belly to belly activity. All groups were described as surface active, in that they frequently and quickly changed speed and direction. Focal animals were less than one body length apart and either in proximity to or several body lengths from other group members. All species were recorded rolling onto their sides and/or back while at or near the surface. Open mouth display also occurred in the right whale event. Though copulation is unlikely to have transpired during the sperm whale event and could not have occurred during the right whale event due to same-sex individuals, it cannot be ruled out as the impetus for the sei whale event. These events begin to describe the relative importance of the New York Bight as not just a migratory corridor and suggest that additional behaviorally focused data collection be incorporated into future surveys.

Disentangling The Impacts Of Fisheries Management Measures On Whale Bycatch Risk
Leena Riekkola1, Owen Liu2, Blake Feist2, Karin Forney1, Briana Abrahms3, Elliott L. Hazen4, Jameal Samhouri6
1Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA, Seattle, Washington, 2National Oceanic and Atmospheric Administration, 3NOAA, NMFS, Southwest Fisheries Science Center, Moss Landing, California, 4University of Washington, 5Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, Monterey, CA, 6Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA

Designing measures to mitigate entanglements in fishing gear is highly challenging. The effectiveness of different management strategies can vary between years and the affected species. We investigated the effectiveness of gear restrictions during 2019 and 2020 in the highly valuable Washington Dungeness crab (Metacarcinus magister) fishery as a strategy to mitigate large whale entanglements off the U.S. west coast. Using logbooks, we first quantified spatio-temporal patterns of fishing effort. We then combined logbook based effort with habitat models for protected blue (Balaenoptera musculus) and humpback whales (Megaptera novaeangliae) to investigate how a newly established 33% reduction in crab pots during summer and fall, when whales are present in the region, influenced entanglement risk. Finally, we quantified the impact of the new regulations on the fishery using landings and revenue data. Although the spatio-temporal patterns of fishing effort were highly variable between years, the fishery generally constricted and concentrated closer to the coast in late summer. We measured fishing effort (pot density; pots/km²) and risk reduction to whales in two ways (fishery effort-centric and whale-habitat centric), and both produced qualitatively similar results. In years with pot reductions, the mean and maximum pot densities were reduced by around 25% and 40%, respectively, both within the fishery footprint and the most likely whale habitat. Risk to blue and humpback whales was reduced by ~24% and ~44%, respectively, however, the lowered risk appeared to be driven by changes in whale distribution in one year, and by gear restrictions in the other. Revenue and the amount of crab landed varied between years, but were comparable between years with and without regulations. Gear restrictions can therefore be a cost-effective strategy to reduce entanglement risk, but the complicated interaction between the distribution of both fishing gear and whales should not be overlooked when assessing entanglement risk.
Advancing ropeless fishing in the Gulf of Maine to protect endangered North Atlantic Right Whales
Richard Riels¹, Kevin Rand²
¹SMELTS, Sedro Woolley, WA, ²Sea Mammal Education Learning Technology Society

Richard Riels Executive Director of SMELTS.org invented innovative Ropeless liftbag fishing technology to end entanglements to large whales in trap/pot commercial fisheries. SMELTS will present the grassroots work we have been doing with commercial fishermen in the Gulf of Maine to utilize the SMELTS line free lift bag fishing technology to protect North Atlantic right whales. SMELTS will present on the methodology of fishing and marking commercial fishing gear with no vertical lines or buoys and the progress made on this new fishing technology.

The ecological role of the Galapagos sea lions in the ecosystem of the Southeastern Galapagos Archipelago
Marjorie Riofrio-Lazo¹, Francisco Arreguín-Sánchez¹, Manuel Zetina-Rejón¹, Diego Paez-Rosas²
¹Universidad San Francisco de Quito, Galapagos Science Center, Pto. Baquerizo Moreno, Galapagos Islands, Ecuador, ²Universidad San Francisco de Quito, San Cristobal, Galapagos, Ecuador

From an ecosystem-based management perspective is relevant to understand the functional role of the species to protect not only charismatic or economically valuable species but also those irreplaceable in the community based on their contribution to the organization, function and resilience of the ecosystem. By using a trophic model of the Southeastern Galapagos Archipelago, we analyzed structural and flow-based indices estimated for 72 functional groups to identify the role of the species in the ecosystem context, with particular attention to the role of the Galapagos sea lion, an endemic otariid in endangered status. We determined the contribution of each group to the ecosystem’s global attributes, organization and resilience (based on Ulanowicz’s ascendency concept). Low trophic level (TL) groups contribute more to the energy transfer and the ecosystem’s function, as shown by high values of complexity and structural indices. They have the highest contribution to ecosystem maintenance and organization according to their ascendency (A), overhead (O), and development-of-capacity (C) values. These groups along with some upper TL commercial fish contribute more to the increase of the ecosystem’s organization and its development (as expressed by higher values of A/C). The Galapagos sea lion along with other marine mammals, seabirds, and some species of sharks have similar contributions to the ecosystem’s resilience (e.g., high O/C values), showing an important role in the ecosystem’s recovery. The keystone species indices indicated that some of these species, like the Galapagos sea lion, play a key role in the food web, highlighting the role of some endemic and threatened high TL species in the maintenance of ecosystem structure. Our results provide useful information for balancing conservation and fishing policies to support the sustainability and preservation of the ecosystem.

Bouncing baby otters: Analysis of sea otter buoyancy with ontogeny
Kate Riordan¹, Emily Levin², Payton Adema³, Alex Thompson¹, Emeline McMann-Chapman³, Annika Dean¹, Francesca Batac⁴, Nicole Thometz², Heather Liwanag⁶
¹California Polytechnic State University - San Luis Obispo, San Luis Obispo, CA, ²California Polytechnic State University, San Luis Obispo, ³California Polytechnic State University San Luis Obispo, ⁴CA Dept. of Fish & Wildlife - Office of Spill Prevention & Response, ⁵University of San Francisco, San Francisco, CA, ⁶California
Buoyancy in marine mammals is crucial for survival in the aquatic environment, and buoyancy can vary across species. The air layer trapped in the dense pelage of sea otters (Enhydra lutris) is important for both thermoregulation and buoyancy, allowing the animals to float effortlessly at the surface. Past studies have investigated the buoyancy of adult otters, but no one has examined whether or how buoyancy changes throughout their lives. In this study, we investigated possible changes in buoyancy as otters age, as well as the effects of crude oil on the buoyancy of otter pelts. We hypothesized that lanugo (neonatal) otter pelts would be more buoyant, as it is known that pups cannot dive for their first months of life. Using an underwater scale, we measured buoyancy for sea otter pelts (n=38) across 6 age classes. We calculated the buoyant force of pelts under normal conditions, after applying crude oil, and after washing with Dawn©. We found no difference in pelt buoyant force across age classes (p=0.0825). This suggests the buoyancy of the fur is not what prohibits pups from diving; but there are other physiological and morphometric variables at play, particularly when these measurements are scaled to whole animals. However, buoyant forces were significantly higher in control pelts compared to oiled and washed pelts for all ages (p<0.0001). A possible explanation for this is the crude oil disturbs the air layer and reduces the insulative and buoyant properties of the fur. Additionally, Dawn© may be removing natural oils from the fur that aid in buoyancy. We will use live sea otter buoyancy observations collected at Monterey Bay Aquarium to validate our scale estimations. This study represents the first step towards understanding buoyancy during ontogeny for sea otters, and provides insight into how contaminants affect the functionality of the pelage.

Verminous pneumonia as a cause of death in an Antillean manatee from Puerto Rico

Carla Ivette Rivera-Perez1, Michelle M. Dennis2, Juan M. Orcera Iglesias3, Lesly J. Cabrias-Contreras4, Antonio L. Rivera-Guzman1, Antonio Mignucci6
1Ross University School of Veterinary Medicine, San Juan, Puerto Rico, 2University of Tennessee, Knoxville, Tennessee, 3Inter American University of Puerto Rico, Bayamón, Puerto Rico, 4Puerto Rico Manatee Conservation Center, 5Puerto Rico Manatee Conservation Center, San Juan, PR, 6Manatee Conservation Center, Bayamon, Puerto Rico

Manatees, like other species of aquatic mammals, harbor a variety of endo- and ectoparasites, which can directly or indirectly affect their immune system, causing severe, little or no pathological lesions. However, pre-existing conditions may push these parasite populations to over-grow within the host, causing disease processes which may lead to death. Here, we report the first case of verminous pneumonia as the cause of death in an adult female Antillean manatee (Trichechus manatus manatus) rescued on the southern coast of Puerto Rico. Upon rescue, the manatee presented severe respiratory problems accompanied by a poor body condition. This disease was caused by the migration of the nasal trematode Pulmonicola cochleotrema through the nasal cavity into the airways causing a bilateral purulent congested hemorrhagic pneumonia. The manatee died the next day and macroscopic findings during the postmortem examination and histopathological analysis confirmed verminous pneumonia as the cause of death. Verminous pneumonia has been reported in different species of mammals, both terrestrial and aquatic, including the Florida manatee subspecies (T. m. latirostris). Understanding a species’ normal parasitic fauna and how these helminths may truly affect the animal is important in the overall rescue treatment, management and protection of endangered
species like the manatee, particularly in small populations like those found in the Caribbean.

**Evidence of human-induced trauma in two species of pinnipeds in the Southwest Atlantic Ocean**

Maite De Maria¹, Meica Valdivia², Susan Underkoffler¹, Adam W. Stern³, Florencia Artecona¹, Jason Byrd⁴, **Sabrina Riverón⁵**

¹University of Florida, GAINESVILLE, FL, ²Montevideo, Uruguay, Uruguay, ³University of Florida, Wildlife Forensic Sciences Faculty, ⁴University of Florida, College of Veterinary Medicine, Gainesville, Florida, ⁵Universidad de la República, Facultad de Ciencias, Montevideo, Uruguay, ⁶University of Florida College of Medicine, Gainesville, Florida, ⁷Macquarie University, Uruguay

Human-wildlife conflicts occur when there is a real or perceived adverse effect on each other, as it occurs with the interactions between pinnipeds and fisheries. Pinnipeds are motivated to forage on easily available fish trapped in fishing gear that can result in deliberate or accidental trauma of the animal. Our objective was to evaluate human-induced trauma in the two pinniped species, *Arctocephalus australis* and *Otaria byronia*, off the Uruguayan coast in the southwest Atlantic Ocean, where they overlap with recreational, artisanal, and industrial fisheries. A total of 303 skulls, 201 *A. australis* and 102 *O. byronia*, were inspected for signs of possible human-induced trauma such as fractures, presence of projectiles or possible healed wounds. Radiographs were performed and analyzed by experts in ballistic and wildlife forensics to confirm the presence of metallic fragments. Ten percent of the skulls (n=30) showed signs of human-induced trauma; 19 of them belonged to *O. byronia* and 11 to *A. australis*. Results show that the probability of human-induced trauma was significantly higher in *O. byronia* than in *A. australis*, with an effect size of 3.89. Any dead *O. byronia* has a 12-30% probability of having signs of human-induced trauma. Gunshot wounds were the most common type of trauma that included single and multiple projectiles. Seven individuals had ossification processes surrounding the injuries, and two individuals had different types of projectiles with evidence of healing. Our results show a high prevalence of human-induced trauma in the southwest Atlantic ocean with a higher prevalence in *O. byronia*, which coincides with the more coastal feeding habits and higher interaction with fisheries compared to *A. australis*. The systematic removal or injury of individuals to avoid interactions with fisheries is an illegal and ineffective deterrent mechanism. Human-induced trauma could also increase the vulnerability of a declining marine mammals population.

**Mortality event due to suspected freshwater skin disease outbreak in the Burrunan dolphin (Tursiops australis), Gippsland lakes, Victoria, Australia**

Kate Robb¹, Chantel Foord²

¹Marine Mammal Foundation, Mentone, Victoria, Australia, ²Marine Mammal Foundation & RMIT, Australia

The iconic and endangered Burrunan dolphin (*Tursiops australis*), resident to the Gippsland Lakes, Victoria, Australia, is under immediate risk of localised extinction. A recent mortality event has seen the death of at least 20% (known and presumed) of the maternal-based population within a six-month period. Recent devastating bushfires and increased rainfall has seen complex environmental changes to the Gippsland Lakes, such as increased sedimentation, dramatic salinity declines, temperature changes and anoxic conditions. Ulcerative dermatitis, known as freshwater skin disease (FWSD), has been characterised via Australian case-studies, including the 2007 mortality event from Gippsland Lakes, during which similar environmental conditions to those observed in
2020, were documented. These case studies involved an abrupt and marked decline in salinity, with prolonged exposure to hypo-saline conditions resulting in ulcerative skin lesions, and in some cases, death. Here we document a much more severe FWSD lesion outbreak and mortality event, alongside assessment of environmental conditions throughout the 2020-2021 period. Environmental data collected during the study period shows a rapid decline in salinity across five sites. Photographic data demonstrates a significant increase in lesion prevalence, with ~90% of the captured population affected. We provide case studies across the outbreak period, from those that resulted in death, to others showing signs of possible recovery. Of the known deaths, all showed severe ulcerative lesions across their entire body, with secondary bacterial and algal matting. With 20% of the ~65 resident dolphins deceased, at least four being breeding females, and 30% of the population remaining ‘missing’, presumed either deceased or displaced, we predict major short and long-term impacts to the population’s viability, and greater concerns about the species’ persistence and risk of extinction.

**High oxytocin infants gain more mass with no additional maternal energetic costs in wild grey seals (Halichoerus grypus)**

Kelly Robinson1, Neil Hazon1, Sean Twiss3, Paddy Pomeroy4

1Sea Mammal Research Unit, St. Andrews, United Kingdom, 2University of St Andrews, 3Durham University, Durham, United Kingdom, 4Sea Mammal Research Unit, St Andrews, United Kingdom

Maximising infant survival requires secure attachments and appropriate behaviours between parents and offspring. Oxytocin is vital for parent-offspring bonding and behaviour. It also modulates energetic balance and developmental pathways for fat, muscle and bone tissue. However, to date the connections between these two areas of the hormone’s functionality in natural systems are poorly defined. We measured peripheral oxytocin levels, mass changes across lactation and individual behaviour in wild mother-pup pairs of grey seals across two breeding seasons on two island breeding colonies in Scotland. We demonstrate that grey seal (Halichoerus grypus) mothers with high oxytocin levels produce pups with high oxytocin levels throughout lactation, and show for the first time a link between endogenous infant oxytocin levels and rates of mass gain prior to weaning. High oxytocin mother-pup pairs are likely generated via positive oxytocin feedback loops within both individuals, maintaining elevated basal oxytocin levels in bonded pairs throughout lactation. High oxytocin infants gained mass at greater rates without additional energetic cost to their mothers. Increased mass gain in infants was not due to increased nursing, and there was no link between maternal mass loss rates and plasma oxytocin concentrations. Increased mass gain rates within high oxytocin infants may be due to changes in individual behaviour and energy expenditure or oxytocin impacting on tissue formation. Infancy is a crucial time for growth and development, and our findings connect the oxytocin driven mechanisms for parent-infant bonding with the energetics underlying parental care. Oxytocin is highly conserved in structure and function across vertebrates and evidence from rodent, human and dolphin studies demonstrate that elevated basal oxytocin levels occur in infants of these species throughout the periods they are dependent on their mothers. Our study demonstrates that oxytocin release may connect optimal parental or social environments with direct physiological advantages for individual development.

**Time matters: Common and expected postmortem computed tomography observations involving the cetacean brain**

Maria Jose Robles Malagamba1, Henry Chun Lok Tsui2, Brian Chin Wing Kot3, Tabris Yik To

1Sea Mammal Research Unit, St. Andrews, United Kingdom, 2University of St Andrews, 3Durham University, Durham, United Kingdom
Virtopsy, including postmortem computed tomography (PMCT), has been routinely incorporated in human forensics to identify space-occupying intracranial lesions, and to document the normal PMCT features of the central nervous system. In recent years, postmortem neuroimaging has been increasingly applied in marine mammals, particularly for cetacean stranding investigations. Given the various decomposition statuses of cetacean carcasses retrieved, and the rapid decomposition rate of the soft tissues, an understanding of the PMCT findings that reflect the normal decomposition process is essential to prevent misinterpretation of normal findings as pathologic processes. Our objective was to characterize the normal postmortem imaging findings of cetacean brains with the use of PMCT, and the effect of time in the appearance of these changes. PMCT brain images of 13 deceased cetaceans with no evidence of head trauma or central nervous system pathology, were retrospectively analyzed. Time from death/retrieval to PMCT examination varied from 45 minutes to 72 hours. Differentiation of the grey-white matter was still observed one hour after death, with the loss starting two hours postmortem. Normal postmortem intravascular blood distribution was not visualized in any animal, possibly due to the limited capability of PMCT to depict small collections of blood without the contrast administration. Effacement of the ventricles was observed in 5 animals (38.4%), while hyperattenuation of the vasculature was visualized in 3 (23%). Presence of intravascular gas was observed in 5 animals (38.4%) approximately 20 hours postmortem, but 8 hours postmortem in 1 animal, possibly related to improper preservation before the PMCT scanning. Time from death/retrieval to PMCT examination, as well as imaging exposure parameters, are important factors to consider for cetacean brain virtopsy assessment. This study serves as a baseline reference of PMCT brain appearance for clinical and postmortem diagnosis of cetacean central nervous system pathologies.

Sea ice anomalies affect the acoustic presence of Antarctic pinnipeds in their breeding areas

Irene Roca¹, Lars Kaleschke², Ilse Catharina Van Opzeeland³  
¹Helmholtz Institute for Functional Marine Biodiversity (HIFMB), Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI), Oldenburg, Lower Saxony, Germany, ²Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI), Germany, ³Alfred Wegener Institute for Polar and Marine Research, Bremerhaven

The Southern Ocean’s cryosphere plays a critical role for many Antarctic migratory and resident marine species. Although critical to interpret and mitigate the effects of extreme climatic events on polar species, knowledge of the effects of strong negative sea-ice cover anomalies on the reproductive activity dynamics of the true Antarctic pinniped species is still scarce. Using 8-year continuous passive acoustic monitoring data, we quantify the effect of local sea-ice conditions on the acoustic presence probability of the four ice-breeding species in their breeding area. While the acoustic activity timing was constant across years for all four species, the activity decreased during sea-ice cover conditions <10%, such as those prevailing during the summer 2010-2011. This suggests that the ice-dependent species may not immediately adapt their breeding phenology to rapid changes in sea-ice cover. Therefore, extreme and regular negative anomalies in early-summer sea-ice cover could potentially affect long-term reproductive success by preventing seals from finding optimal ice floes to haul out and
reproduce in their traditional breeding area. Increasing our understanding of how true Antarctic predator species may cope with climate-driven changes in their habitat, is key to effective conservation measures to sustain the integrity and functionality of the ASO ecosystem.

**Sustainability of a dolphin-swim program inside a marine protected area in southern Mozambique**

Diana Rocha¹, Sarah Marley², Benjamin Drakeford³, Jonathan Potts³, Angie Gullan⁴

¹School of Environment, Geography and Geosciences - University of Portsmouth, Estoril, Lisbon, Portugal, ²Scotland’s Rural College (SRUC), Portsmouth, Hampshire, United Kingdom, ³University of Portsmouth, Portsmouth, United Kingdom, ⁴Dolphin Encountours Research Center, Maputo, Mozambique

Cetacean tourism activities can negatively impact target populations. It is important to consider the behavioural responses of dolphins, as well as maximise opportunities for sustainable tourism that benefits socio-economic growth whilst encouraging pro-environmental behaviour. This is of particular relevance in developing countries, where ecological studies are poorly documented and tourism industries may have developed before management measures were implemented. This study utilised a combination of social science and ecological research techniques to investigate the sustainability of dolphin-swim tourism in the Ponta do Ouro Partial Marine Reserve (PPMR) in Mozambique. This is the number one destination in the country for wild dolphin-swim activities. Hand-out questionnaires were used to examine the attitudes and perceptions of dolphin tourism, among both operators and tourists. This revealed that operators were sometimes uncertain whether to break the rules when pressured by tourists. However, tourists were greatly in favour of well-regulated activities, and placed high importance on education and interpretation. Therefore, follow-up work investigated the benefits of training workshops for tourism operators. Results indicated a significant improvement between pre- and post-training scores on a knowledge test, as well as an overall positive change in the attitudes of operators towards such training. A 25-yr dataset of bottlenose dolphin (*Tursiops aduncus*) demographics and behaviour was used to investigate the short- and long-term behavioural responses to tourism activities. Markov chains assessed the predominant activity state of dolphins before, during, and after approach by tourism vessels. Behavioural budgets during historic periods of low tourism were also compared with higher contemporary levels. In both cases a decrease of socialising and resting behaviour was observed. These results are directly applicable to improving management measures within the PPMR, as well as other developing countries. Overall, this work demonstrates the importance of an interdisciplinary approach for ensuring sustainable cetacean tourism.

**Group Sizes, Activity Patterns and Acoustic Production of Three Delphinid Species in Azores**

Clara Rodrigues¹, Manuel E. dos Santos², Ana Rita Luís³

¹Research Institute of Marine Sciences - Okeanos, Lisboa, Portugal, ²MARE-ISPA, ISPA-CRL 501 313 672, Lisboa, Portugal, ³ISPA - Instituto Universitário, Portugal

Whistles are essential social calls of delphinids. The emission rates and frequency parameters of these sounds vary according to species for reasons not yet entirely clear. This study compares the whistle repertoires of three seasonally sympatric delphinid species that are commonly sighted during the summer in the Atlantic archipelago of the Azores, namely *Tursiops truncatus*, *Delphinus delphis* and
Stenella frontalis. Whistles were recorded at a 96 kHz sampling frequency, from August 24th to October 14th, 2019 around the Faial and Pico islands. Activity patterns and the groups size for each sighting were also noted. Raven Pro 64 1.4 was used for acoustic analysis and calculation of whistle emission rates. From the whistle samples, 484 were selected for T. truncatus (n = 175), S. frontalis (n = 282) and D. delphis (n = 27).

Acoustic parameters and frequency contours categories were measured and compared. T. truncatus and S. frontalis exhibited an average emission rate significantly higher than D. delphis. Common dolphins had significantly lower emission rates than Atlantic spotted dolphins during travelling. Furthermore, the three species presented specific vocal characteristics in both whistle parameters and frequency contours categories. For example, there were significant differences between T. truncatus and D. delphis in the initial, final, minimum, central, and peak frequencies. As for whistles contours, the most observed category for S. frontalis was Sinusoidal, while for T. truncatus and D. delphis was Upsweep. Interestingly, some acoustic parameters of the three species showed greater similarity with more remote populations rather than those from closer geographic locations. Detailed knowledge of delphinid vocal behavior is important for passive acoustic monitoring. As dolphins can present significant differences in whistle characteristics between distinct species, but also within the same species, it is relevant to investigate and compare several species and populations in different locations.

Cedofeita, Portugal, ¹FCUP - Faculty of Sciences, University of Porto, CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, Porto, Portugal, ¹Interdisciplinary Centre of Marine and Environmental Research (CIIMAR), Matosinhos, Porto, Portugal, ¹VAT# PT501413197 Universidade do Porto - Faculdade de Ciências, Porto, Portugal

Long-term monitoring datasets can provide a baseline to better understand physical and ecological responses to ocean environmental changes. These datasets can play an important role in marine management and conservation, so it is imperative that they become public, following FAIR Data Principles, to enhance their reusability. It is also fundamental that the data is reliable, and the sources of bias are identified and quantified. CETUS Project is a cetacean monitoring program in the NE Atlantic, ongoing since 2012, that counts on international participation of biologists to collect data on long-transect routes, from large vessels used as platforms of opportunity. CETUS dataset is made available open-access at OBIS and EmodNET portals. This work aimed to optimize and allow the proper use of the dataset by: i) applying verification / validation methods, based on photographic confirmation of identified species; ii) creating criteria for the quality of the data, based on the observers experience; and iii) assessing the influence of bias parameters, using Generalized Additive Models to correlate number of sightings and number of non-identified species of the surveys with weather conditions, height of observation platform, experience of observers, and distance of sighting to the vessels.

From the collected photographic records, we were able to match 90.98% with the dataset occurrences, although corresponding only to 7.72% of the total dataset. Out of the matched records, 74.22% sightings were validated, out of which 13.59% non-identified records were identified to a lower taxon, and 3.48% wrong

Optimization of a cetacean occurrence dataset: controlling methods for data bias, verification, and validation
Cláudia Rodrigues¹, AGATHA GIL², Raul Valente³, Isabel Sousa-Pinto⁴, Mafalda Correia⁵ ¹Interdisciplinary Centre of Marine and Environmental Research (CIIMAR-UP). VAT: PT508792657. LO#258457, Matosinhos, Portugal, ³UTAD, CIIMAR, CSIC, Porto,
identifications were corrected. This reveals the importance of verification/validation methods and the need to increase photographic registers during sampling. GAMs revealed which variables most affect monitoring efficiency and permitted the establishment of monitoring thresholds. Ultimately, the work will contribute to more informed use of the dataset, and to an improvement of monitoring protocols of CETUS and similar programmes.

Spatial and temporal variation in the occurrence of bottlenose dolphins in the Chesapeake Bay, USA, using community science sighting data
Lauren Rodriguez¹, Amber Fandel¹, Helen Bailey¹, Benjamin Colbert¹, Jamie Testa³
¹University of Maryland Center for Environmental Science: Chesapeake Biological Laboratory, Alexandria, Virginia, ²University of Maryland, Arlington, VA, ³University of Maryland Center for Environmental Science, ⁴University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory, Solomons, MD

Bottlenose dolphins (Tursiops truncatus) are migratory marine mammals that live in both open-ocean and coastal habitats. Although widely studied, little is known about their occurrence patterns in the highly urbanized estuary of the Chesapeake Bay, USA. Therefore, the goal of this study was to establish the spatial and temporal distribution of bottlenose dolphins throughout this large estuarine system as well as use statistical modeling techniques to determine how their distribution relates to environmental factors. Three years (April-October 2017-2019) of dolphin sighting reports from a community science-driven database, Chesapeake DolphinWatch, were analyzed. Each year, the dolphins had a distinct temporal pattern, most commonly being reported by volunteer scientists during summer months - peaking in July. This seasonal pattern of observed occurrence was confirmed with systematic, passive acoustic detections of dolphin echolocation clicks from local hydrophones that were deployed in the Chesapeake Bay from 2017 through 2019. Using spatially-exclusive Generalized Additive Models (GAM), dolphin presence was found to be significantly correlated to spring tidal phase, warm water temperature (24-30 °C), and salinities ranging from 6 – 22 PPT. Further, we were also able to use these GAMs to predict dolphin occurrence throughout the Bay. These predictions were statistically correlated to the actual number of dolphin sighting reported to Chesapeake DolphinWatch during that time. Statistical modeling techniques applied to species presence data, such as the method presented here, can be implemented to inform regional management of protected marine mammals, including the bottlenose dolphin. In an area characterized by commercial shipping operations, recreational boating, and coastal construction, it is important that managers in and around the Chesapeake Bay ecosystem take note of the times and places in which marine mammals may be adversely impacted by anthropogenic activities.

Endocrine, genetic, and metagenomic analyses from respiratory samples collected via SnotBot drone
Andy Rogan¹, Iain Kerr¹, C. Scott Baker⁴, Jorge Urban¹, Kendall Mashburn¹, Debbie Steel¹, Angela Sremba⁴, Logan Pallin⁷, Chris Zadra⁸, Alicia Pensarosa¹, Matthew Redlinger⁹, Maile Branson⁹, Amy Klink¹⁰, Ralf Dagdag¹⁰, Eric Bortz¹¹, Shannon Atkinson DeMaster¹², Jennifer Polinski¹³
¹Ocean Alliance, Gloucester, MA, ²Marine Mammal Institute, Oregon State University, Newport, OR, ³Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico, ⁴University of Alaska Fairbanks, Juneau, AK, ⁵Fisheries and Wildlife Department and Marine Mammal Institute, Oregon State University, Newport, OR,
The diversity of unmanned aerial systems (UAS) applications has greatly increased in marine mammal science over the past decade. The applications of UAS technologies for health assessments of large whales are intended for progressive and significant improvements for cetacean health management. Here, we present endocrine, genetic, and metagenomics analyses of respiratory blow samples with the goal of improving current and future management of large whale health and conservation. The data are from blow samples that were collected from humpback whales (*Megaptera novaeangliae*), blue whales (*Balaenoptera musculus*), fin whales, (*Balaenoptera physalus*), and killer whales (*Orcinus orca*). Endocrine analyses validated 5 steroid hormones in humpback whales and 4 steroid hormones in blue whale blow samples. We extracted and amplified both nuclear and mitochondrial DNA from 47 respiratory blow samples and determined mtDNA haplotypes (n=30 at 400 bp), sex (n=22), and genotypes for individual identification (n=8) for a subset of the samples. DNA profiles from two of the humpback whales were matched using a DNA register for this regional population. Metagenomic classifications analyzed by nanopore sequencing in humpback whale blow included bacteria, eukaryotes (likely planktonic plants and fungi), archaea, and viruses (bacteriophages and marine ssDNA viruses). A comprehensive integration of laboratory-based analyses using UAS collection technologies could become one of the most important management tools in health assessments of large, and often difficult to study, cetaceans.
the survey area for bottlenose dolphins varied from 1.43 million MJ/day to 21.37 million MJ/day and for harbour porpoise ranged from 255,477 MJ/day to 660,825 MJ/day. The energetic requirements of harbour porpoise are met by smaller teleost species including silvery pout, *Trisopterus* spp. and whiting whereas for bottlenose dolphins, the energetic demands are met by larger gadoid fish species, including haddock/pollack and saithe, as well as whiting/blue whiting and hake. These seasonally explicit bioenergetic models could be used to better understand the complex ecological and trophic interactions of bottlenose dolphins and harbour porpoises with their prey populations and to evaluate their role in the wider ecosystem.

**Crime scene Wadden Sea – Do Gray Seals (Halichoerus grypus) have a negative impact on other Marine Mammals in German waters?**

*Simon Rohner*¹, Kirsten Hülskötter², Stephanie Gross³, Peter Wohlsein¹, Abbo van Neer⁵, Ursula Siebert⁶

¹Institute for Terrestrial and Aquatic Wildlife Research, University of Veterinary Medicine Hannover, Foundation, Büsum, Schleswig-Holstein, Germany, ²Department of Pathology, University of Veterinary Medicine Hannover, Foundation, Germany, ³University of Veterinary Medicine Hannover, Foundation, Institute for Terrestrial and Aquatic Wildlife Research, Bokholt-Hanredder, Schleswig-Holstein, Germany, ⁴Department of Pathology, University of Veterinary Medicine Hannover, Foundation, Hannover, Germany, ⁵Institute for Terrestrial and Aquatic Wildlife Research, Büsum, Schleswig-Holstein, Germany, ⁶Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Buesum, Schleswig-Holstein, Germany

As Germany’s largest carnivore, gray seals seem to fill in the role as apex predator. They share the habitat with two other top predators – harbour seal (*Phoca vitulina*) and harbour porpoise (*Phocoena phocoena*). Whereas harbour seals are present in stable numbers in the German Wadden Sea and adjacent waters, the gray seal population is still recovering from former local extinction. All three species mainly prey on fish, whereas recent research has shown that gray seals also utilise high energetic prey such as marine mammals. Characteristic lesions of harbour porpoises found dead could be identified as bite wounds and lacerations caused by gray seals. Mainly on the German Island Helgoland, cases of active cannibalism and predation of gray seals on harbour seals and conspecifics are reported for several years. Additionally to these cases, in the winter of 2018-19, 11 adult female harbour seals were found dead along the coast of Northern Germany. All individuals showed signs of recent pregnancy and/or abortion. Further, they displayed severe genital lacerations, in some cases together with septic spread of bacteria. Extensive diagnostics detected spermatozoa in the genital lacerations, which could genetically be identified as originating from a gray seal. Sexual coercion with fatal outcome is the presumed cause of death in this to date unique event. Besides infectious diseases or drowning in fishing gear, encounters with gray seals need to be considered as cause of death for marine mammals not only through predation but also through other behaviour shown. In the Wadden Sea, gray seals potentially have a negative impact on other marine mammals locally as predators or on breeding female harbour seals. Still, only certain male individuals seem to display such behavior. More research, including post mortem investigations, needs to be conducted on the diet and behaviour of the growing gray seal population.
Linking Effort-based Biological Observations and Oceanographic Conditions, a Tool for Management Decision Makers to Enhance Resiliency and Protection of Marine Mammals – a Collaborative Approach in Central and Northern California
Jan Roletto¹, Dawn Goley², Patrick Daniel³, Kirsten Lindquist⁴, Allison Lui⁵, Jaime Jahncke⁶, Danielle Lipski⁷
¹Research Coordinator, Greater Farallones National Marine Sanctuary, San Francisco, California, ²Cal Poly Humboldt, Arcata, California, ³Central & Northern California Ocean Observing System, MBARI, Moss Landing, CA, ⁴Greater Farallones Association, San Francisco, CA, ⁵Humboldt State University, ⁶Point Blue Conservation Science, Petaluma, CA, ⁷Cordell Bank National Marine Sanctuary, Point Reyes, CA

Integrated real-time and archived oceanographic data and marine mammal observations from North-central California are newly available through the Central and Northern California Ocean Observing System’s (CeNCOOS) data portal to support marine mammal management efforts in the region. We report on the collaboration between CeNCOOS and three long-term marine mammal, effort-based monitoring (EBM) projects: Humboldt State University Marine Mammal Stranding Program, Beach Watch [led by Greater Farallones National Marine Sanctuary (GFNMS) and Greater Farallones Association], and Applied California Current Ecosystem Studies (led by Point Blue Conservation Science, GFNMS and Cordell Bank NMS). The CeNCOOS data portal includes over 1,100 oceanographic and biological data sets, including physical oceanography, surface current data, models and forecasts obtained through real-time observations and gliders that can be integrated with biological observations such as at-sea and shoreline observations of live and dead marine mammals. Linking standardized, EBM marine mammal observations with real-time and forecast oceanographic conditions can provide time-sensitive data needed to make informed management decisions such as, documenting early indicators of a mortality event in stranded marine mammals, determining the extent and potential oceanographic drivers of an unusual mortality event, and predicting the potential of a mortality event based on oceanographic conditions. Other management uses of the CeNCOOS data portal include determining if marine heat waves, storm events, poor upwelling conditions, or harvesting forage species are correlated with increased beachcast deposition of marine mammal carcasses or changes in abundance and distribution of marine mammals into areas of increased risk of vessel collisions or entanglement. This collaboration of web-based mapping serves as a template for other monitoring programs to build EBM stranding and at-sea monitoring collaborations with Ocean Observing Systems to facilitate robust statistical assessment of biological data over large areas of coastline and identify marine mammals that are at increased risk to human pressures.

Pearl and Hermes Reef: Paradise or Peril? Evaluating the Role of Conspecific Aggression in a Declining Subpopulation of Endangered Hawaiian Monk Seals
Hope Ronco¹, Thea Johanos², Darren Roberts², Paige Mino³, Albert Harting⁴, Jason Baker¹
¹Protected Species Division / NOAA / PIFSC, Honolulu, HI, ²Hawaiian Monk Seal Research Program, Honolulu, HI, ³Cooperative Institute for Marine and Atmospheric Research, University of Hawaii, ⁴Harting Biological Consulting, Bozeman, MT

The Hawaiian monk seal (Neomonachus shauinslandi) subpopulation at Pearl and Hermes Reef has experienced several years of poor survival from weaning to age one, which combined with inconsistent annual pup production, has led to a 23% decline in abundance at this site between 2011 and 2019. A
lifetable parameterized with survival rates estimated during 2017 to 2019 yielded an intrinsic growth rate of 0.96, while six other subpopulations had estimated rates >1.0. Only 18% of seals survived to age 7 at Pearl and Hermes Reef, while other subpopulations had ~30-40% survival to the same age. Explanations for these trends are not known; however, there are indications that adult male aggression towards conspecifics at certain islets within the atoll may play a role. We investigate the role of male aggression as a threat to the subpopulation in two ways. We evaluate how the presence and extent of characteristic male mounting injuries, inflicted on weaned pups and detected within the summer field season, impact pup survival to year one for 184 animals born between 2011 and 2019. During the 2018 and 2019 seasons, 39 of 47 pups were born or first observed at North and Little North. Of those 39, 21% were documented with characteristic male mounting injuries and two adult male aggressive interactions towards pups were observed by researchers. We also examine healed scars on juveniles and older animals to evaluate injuries inflicted between seasons. Current mitigations include translocation of weaned pups from those islets with observed male aggression to an islet with minimal male aggression and medical interventions to treat injured animals. Deeper understanding of conspecific aggression as a threat to survival will help us to better direct conservation actions to support the recovery of this endangered species.

Movements and Diving Behavior of Risso’s Dolphins in the Southern California Bight
Brenda Rone1, David Sweeney2, Erin Falcone3, Stephanie Watwood4, Gregory Schorr4

Risso’s dolphins (Grampus griseus), uncommon prior to the 1970’s, are now regularly observed within the Southern California Bight. During long-term cetacean monitoring programs on United States Navy range areas in the Southern California Bight from 2009–2019, we deployed 16 Argos-linked satellite tags on Risso’s to acquire objective, detailed depictions of their movements and behaviors. Individuals were tracked for a median of 10.7 days (range=0.8–19.7). Kernel density estimation suggested individuals utilized the entire Southern California Bight with the 50% core use area centered around San Clemente and Santa Catalina Islands where most of the tag deployments occurred. Grand median dive depth was 101 m (max=528) and dive duration was 5.6 min (max=11.1). We used generalized linear mixed models to assess seasonal and environmental effects on distribution and diving behavior including month, distance to shore, time of day, moon lunar phase, sea surface temperature, and chlorophyll-a residuals. Animals were further from shore (including islands) during a full versus new moon and from the mainland during the last versus first quarter moon. Animals also tended to be closer to land in the fall and early winter months. Dives were deeper yet shorter during the night, during a full moon, and when animals were further offshore. Animals conducted nearly twice as many dives at night compared to day, though deep dives (>500 m) occurred at all times of day. This study provides insights into Risso’s distribution and behavioral trends while identifying priorities for future research.

Challenges to Marine Mammal Photo-ID Data Stewardship - Planning for the Future
Errol Ronje1, Antoinette Gorgone2, Megan Cromwell1, Kirsten Larsen1
1NOAA National Centers for Environmental Information, Stennis Space Center, MS,
Datasets that are not archived for long-term accessibility can be lost to science as investigators retire or die, research studies end, due to hard drive or server failure, or by natural disaster. To better understand the challenges and resource requirements related to photo-ID data stewardship, we conducted a 14-day survey of the international marine mammal community via the MARMAM listserv. Survey respondents (n=100) reported photo-ID work globally in 35 different geographical areas (46% North America, 24% Europe, 9% Australia, 9% South America, 7% Africa, 5% Asia, <1% Antarctica); were primarily funded by non-profit (38%) or government organizations (35%), used small-boat platforms (57%), and standard data management software for photo analysis (46%) of >1 catalog (56%). Respondents (40%) reported collecting relatively large volumes of raw photo-ID data (>1 TB), but 88% indicated their resulting photo-ID catalogs were <100 GB, that was stored on physical hard disk drives (44%), or an online cloud-based platform (38%), including 9 collaborative photo-ID data sharing platforms. Most respondents (82%) required a written data sharing agreement for other researchers before providing data for collaborative research, and 60% expected co-authorship as a condition of sharing their photo-ID data. No respondents indicated their data were archived on a publicly accessible platform. Open data policies tend to increase research quality and quantity, promote collaboration and technological advances in analytical tools, are critical to scientific reproducibility and replicability, and increase the effectiveness of scientists to reach conservation and management objectives. However, researchers may be wary of potential costs incurred by openly sharing data without agreements between collaborators. These preliminary results provide insight into photo-ID data management practices, recently developed tools and collaborative platforms, and suggest a need for a cohesive, long-term archival solution for open and convenient public access to marine mammal research data that meets the needs of all stakeholders.

What we know about skinny whales: Assessment of Gray Whale Poor Body Condition During 2018-2021 Winter Breeding Seasons in San Ignacio Lagoon and Magdalena Bay, BCS, México

Floryser Ronzón Contreras¹, Sergio Martinez Aguilar², Steven Swartz³, Jorge Urban⁴, Lorena Viloria Gomora⁵

¹Departamento Académico de Ciencias Marinas y Costeras- UABCS, La Paz, Baja California Sur, Mexico, ²Programa de Investigacion de Mamiferos Marinos, Mexico, City, ³Laguna San Ignacio Ecosystem Science Program, Darnestown, ⁴Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico, ⁵Universidad Autonoma de Baja California Sur, La Paz, Baja California Sur, Mexico

The Eastern North Pacific gray whale (Eschrichtius robustus) population has successfully recovered from mass exploitation during the 19th and early 20th centuries. However, during the 2019-2021 unusual mortality event, many stranded whales were observed in poor Body Condition (BC). Assessing BC during the winter breeding season can be helpful to understand their nutritional condition in the summer feeding season around the Bering, Chukchi, and Beaufort Seas. Evaluation of BC is important for a better understanding the individual health and the overall population. This study was undertaken in two of the three most important areas for gray whale reproduction and breeding: San Ignacio Lagoon (SIL) and Magdalena Bay (BM). We used a non-invasive evaluation method developed for the Western North Pacific gray whales to assess BC. Digital photographs of the whales post-cranial, scapular,
and dorsal areas were assigned a numerical score in three categories (good, fair, poor). Gray whale photographs were analyzed as two separate reproductive-sex groups: Females with calves (Fc), and Single whales (S) that could be a male or a female without a calf. The poor BC proportion for Fc in SIL during 2018-2021 were 2.5% (n=2), 0%, 5.5% (n=3), and 0%, respectively. For S, the poor condition whales increased from 8.2% (n=17), to 23.6 (n=125), 30% (n=150), and 24.4% (n=150), respectively. In BM from 2018-2020, poor condition Fc were, 3.7% (n=1), 7.6% (n=1), and 0%, respectively. For S, the poor condition were 24.3% (n=63), 41.3% (n=112), and 38.2% (n=143), respectively. While Fc did not reflect an increase in the poor BC, their abundance in LSI decreased more than 50% compared to previous years, and more than 50%, compared to the average of Fc photo-identified from 2011-2017 (=226) to 2018-2021 (=57). For S, the proportion of whales in poor BC is the highest recorded in the last 10 years.

Changes in Respiratory Behavior with Swim Speed Suggest Anaerobic Metabolism in Fast-Swimming Lactating Humpback Whales

Marjoleine Roos¹, Katherine Indeck², Michael Noad³, Rebecca Dunlop⁴

¹University of Queensland, The Hague, Netherlands, ²Cetacean Ecology and Acoustics Laboratories group, School of Veterinary Science, University of Queensland, Australia, ³Cetacean Ecology and Acoustics Laboratories group, School of Veterinary Science, University of Queensland, GAtton, Australia, ⁴Cetacean Ecology and Acoustics Laboratories group, School of Veterinary Science, University of Queensland, Dunwich, QLD, Australia

Knowledge of the respiratory energetics of fast-swimming whales is important to understand how they compensate for extended apneic periods of high locomotory energy expenditure rate (EER). However, such knowledge is lacking for baleen whales which are generally inaccessible for physiological measurements. Whales exhibit their highest swim speeds when exposed to an intense stimulus, such as being pursued by a predator. Here, data were used that were collected from migrating humpback whales (Megaptera novaeangliae) with calves up to 20 minutes after being pursued by a vessel for tagging. During this period, some sustained an escape response (increased swim speed, and thus locomotory EER). Using swim speed and respiratory behavior data, their respiratory energetics were investigated over a relatively large range of swim speeds. First, their average swim speed was estimated per breath-hold dive as a proxy of their locomotory EER and it was determined which speeds in these females were higher than ‘normal’. Then, it was modelled how females changed three respiratory behavior variables (breath-hold dive duration, mean inter-breath interval in a breathing bout, and the number of breaths per bout) over the range of swim speeds (including ‘normal’ and ‘high’ speeds). It was found that when swimming at ‘high’ speeds, females exhibited shorter breath-hold dives and longer mean inter-breath intervals during a breathing bout and tended to take slightly more breaths per bout compared to when having ‘normal’ speeds. This change in respiratory behavior may be indicative of the onset of anaerobic metabolism and related lactate production due to the high energy expenditure rate. This study is the first to demonstrate how baleen whales may alter their respiratory behavior to compensate for high locomotory energy expenditure during breath-hold. The presented methods and results provide a foundation for investigating this for other humpback whale cohorts and other large whale species.
Rice’s whale, a new balaenopterid species from the Gulf of Mexico
Patricia Rosel1, Lynsey Wilcox2, Tadasu K. Yamada3, Keith Mullin4
1NOAA Fisheries, Lafayette, Louisiana, 2NOAA Fisheries, Southeast Fisheries Science Center, Lafayette, LA, 3National Museum of Nature and Science, Tsukuba, Ibaraki, Japan, 4NOAA Fisheries Southeast Fisheries Science Center, Pascagoula, MS

Bryde’s whales are medium-sized baleen whales found in tropical and subtropical waters around the world. The number of Bryde’s whale species present in the world has been an area of debate for decades; most recently a single species of Bryde’s whale, Balaenoptera edeni is recognized, with two subspecies, Eden’s whale, B. edeni edeni and Bryde’s whale, B. edeni brydei, although some authors have recognized these as separate species. In 1965, Dale Rice was the first to identify Bryde’s whales as a component of the cetacean fauna of the northern Gulf of Mexico (GoMx). Based on genetic and morphological data, we have determined that these whales represent a unique evolutionary lineage. Mitochondrial DNA sequence data (n=36) identified diagnostic DNA differences for the whales in the GoMx and placed them in a well-supported clade in a Bayesian phylogenetic tree separated from the other Bryde’s whale taxa. In addition, the degree of genetic divergence between these whales and the other closely related taxa exceeded 10%, more than that estimated among other recognized baleen whale species. New morphological comparisons of characters from skulls of Eden’s whale, Bryde’s whale, Omura’s whale, and the whales from the GoMx, also identified diagnostic characters that distinguished among these groups with high probability. While some of the differences in the shape and/or sizes of the bones are subtle, changing bone size and shape generally does not happen quickly in evolution and supports a long independent evolutionary history. With two lines of independent evidence providing diagnostic differences, coupled with high genetic divergence and support for an evolutionarily divergent lineage, these whales in the GoMx meet criteria for species-level recognition. We describe these whales as a new species of medium-sized baleen whale, Rice’s whale, Balaenoptera ricei.

Monitoring Springs to Assess for a Manatee Regional Warm Water Network
Monica Ross1, Nicole Bartlett2
1Clearwater Marine Aquarium Research Institute, Green Cove Springs, Florida, 2Clearwater Marine Aquarium Research Institute

The threatened Florida manatee (Trichechus manatus latirostris) is highly susceptible to cold stress and depends on natural and man-made warm water sources for survival during cold weather. As industrial warm water sources go offline, manatee dependence needs for natural springs will increase. Monitoring manatee use of springs is a high priority within the U.S. Fish and Wildlife Service’s Florida Manatee Recovery Plan in order to address critical data gaps for the development of long-term regional warm water networks, while evaluating site suitability and opportunities for enhancement prior to the cessation of industrial warm water sites. Numerous springs located within the St. Johns River (SJR) could provide a regional network of warm water refuge for both the Upper SJR and East Coast manatee management units. Currently, the only natural winter refuge in these management areas with specific manatee protections is Blue Spring State Park. Clearwater Marine Aquarium Research Institute surveyed six springs in the SJR to assess manatee use, abundance, distribution, recreational use, and site suitability during various winters from 2009-2021. Three springs were identified in need of restoration to remove man-made structures to improve manatee access. Welaka Spring accommodated <12 manatees during extreme cold periods, yet was heavily used during
migration transition, indicating that it is important refuge in the network. Salt and Silver Glen springs provided sustainable winter resources with an increasing annual trend in manatee usage. Food availability within or near both springs drastically declined in 2018. There was an increase in human disturbance and harassment from recreational manatee tourism in recent years. Salt, Silver Glen, and Welaka are vital springs for the regional warm water network that will need adequate protections to safeguard resources, reduce threats, and ensure long-term suitable and sustainability manatee winter refuge.

**There and Back Again: Seasonal timing of humpback whale (Megaptera novaengilae) song on the west coast of southern Africa.**  
**Erin Ross-Marsh**, Simon Elwen, Tess Gridley  
1Sea Search Research and Conservation, Cape Town, Western Cape, South Africa, 2Stellenbosch University, Cape Town, South Africa, 3University of Cape Town, Cape Town, Western Cape, South Africa

The western coastline of southern Africa is a well-established migration route for humpback whale (Megaptera novaengilae) breeding stock B (BSB). These animals migrate through the area from their high latitude feeding grounds to their low latitude breeding grounds. While song is prolific on the breeding grounds, it is also regularly detected on migration routes including at a mid-latitude feeding ground in South Africa. Here we investigate the seasonal timing of humpback whale song during the northward and southward migration of BSB using autonomous moored hydrophones. Data were collected from two different sites along the western coast of South Africa: Kommetjie, Cape Town (-34.1°, 18.2°) and Paternoster, Western Cape (-32.8°, 17.8°) in South Africa, spanning the northward and southward migration from May 2018 to December 2018. Diel patterns and seasonal trends in humpback whale vocalisations were investigated in the recordings using long-term spectral averages (LTSAs). There were strong diel patterns in singing in all locations on the migration route (GAM: p < 0.05). Hourly song presence decreased during midday and peaked in the late evening. Similarly, song presence during the southern migration was also highest during evening hours but remained relatively constant during daytime hours. Daily presence of song for both seasons appeared periodic, where song positive hours showed strong peaks during the monitoring periods. Supported by citizen science sightings data, this pattern of song occurrence apparently reflects the migration of whales in loosely formed aggregations. Overall, our results indicate that diel and seasonal patterns in song will likely reflect both whale presence and behaviour. Inter-seasonal timing of humpback whale song has not been investigated in this area and may provide valuable information for habitat use duration, in terms of social and sexual interactions, for this species along this stretch of coastline.

**Insight of North-East Atlantic common dolphin population demography**  
**Etienne Rouby**, Vincent Ridoux, Matthieu Authier  
1La Rochelle Université, La Rochelle, France, 2Observatoire Pelagis UMS 3462 LRUniv-CNRS, La Rochelle, Nouvelle-Aquitaine, France, 3Observatoire Pelagis UMS 3462 LRUniv-CNRS, La Rochelle, Nouvelle Aquitaine, France

The common dolphin, a widely distributed and abundant odontocete, is very common in the Atlantic Ocean. Only one management unit is currently considered in the North East Atlantic population, ranging from Portugal to Norway. The wide distribution of common dolphin, and the inability to individually identify individuals, make it difficult to estimate vital rates such as survival by following a cohort of individuals from birth to death. Nevertheless, age-at-death data can be collected from stranded animals in order to construct life-tables. A large number of
The strandings of common dolphins happen every year on the French Atlantic seaboard where an efficient stranding network has been collecting biological samples consistently since the 1990s. Using a stratified sampling approach, we selected randomly a representative sample of stranded common dolphins with respect to size, year of death, apparent cause of death and sex. We then aged and determined the sexual maturity of each individual to estimate, with linear mixed models (taking into account covariates and year as a random effect), vital rates such as survival and fecundity for both male and female. Our results suggested that overall survival decreased from 1997 to 2019, and mortality hazard showed a marked increase from 2015 onwards. Only 25% of the population was able to reach age at sexual maturity. Population viability analysis suggested that the population will go extinct within the next 100 years. This worrying trend is largely driven by anthropogenic pressures, most notably bycatch. Large scale surveys did not suggest any decrease in common dolphin abundance in the North-East Atlantic since 2005, but did not cover the whole management unit either. Our results point to the salient question how many management units for the common dolphin in the North-East Atlantic and the pressures acting on this or these population(s).

You are what you eat: Isotope analysis of tooth samples from three dolphin populations along the east coast of South Africa reflect differences in feeding ecology

Natasha Roussouw1, Stephanie Plön2

1Bayworld Centre for Research and Education (BCRE), Port Elizabeth, South Africa, 2Stellenbosch University, South Africa, South Africa

Long-term data collection of dolphins incidentally caught in bather protection nets off KwaZulu-Natal, South Africa, has yielded a valuable dataset spanning five decades. The aim of our study was to investigate differences in δ¹³C and δ¹⁵N ratios between three dolphin species commonly found along the east coast of South Africa and between the sexes of each species as well as examine long-term trends. Tooth powder samples of sexually mature adult Sousa plumbea (n=37), Tursiops aduncus (n=47) and Delphinus delphis (n=49) were analysed. Only the innermost portion of the tooth was drilled, avoiding the pre-weaning layers which are typically enriched due to suckling. In order to determine any changes in feeding ecology over time, samples were grouped into 10-year intervals for each species (1970 – 2016). Our results showed significant differences in the δ¹³C and δ¹⁵N ratios between the three dolphin species (df = 2; P = 0.001), which was confirmed by post-hoc pairwise tests. No significant differences were recorded between the sexes for all three species. PERMANOVA results only indicated a significant difference in both the δ¹³C and δ¹⁵N ratios for S. plumbea over time. A decrease over two 10-year intervals (df = 4; P<0.05) was recorded, namely from the 1990 (δ¹³C = -12.02‰ ± 0.94; δ¹⁵N = 14.78‰ ± 0.46) to the 2000 interval (δ¹³C = -12.71‰ ± 0.50; δ¹⁵N = 14.20‰ ± 0.68) and another decrease in the 2010 interval (δ¹³C = -13.09‰ ± 0.48; δ¹⁵N = 14.01‰ ± 0.38). All three dolphin species appear to be isotopically distinct, reflecting differences in feeding and/or habitat quality, while the decline in δ¹³C and δ¹⁵N ratios of S. plumbea from the 2000s may be indicative of a change in diet. Our results will assist with the design of effective conservation and management strategies of dolphin populations off south-eastern South Africa.

Evaluating the Impacts of Low Salinity Exposure on Bottlenose Dolphins: A Collaborative Project

Teresa Rowles1, Denise Greig2, Erin Fougeres3, Jaclyn Daly4, Alissa Deming5, Abby McClain5, Lance Garrison6, Jenny Litz7, Lorelei Schwacke8, Sarah Wilkin9, Laura Engleby10, Mel Landry11, Ruth Ewing12, Ryan Takeshita13
There have been increasing instances of common bottlenose dolphin (*Tursiops truncatus*) morbidity and mortality associated with low salinity water exposure waters along the coasts of the U.S. These instances have included out-of-habitat situations (e.g., movements up rivers), extreme weather events (e.g., flood events, hurricanes), or coastal projects (e.g., flood or surge protection, or coastal restoration). To improve our understanding of the impacts of low salinity exposure, we synthesized information from multiple sources (published literature, technical reports, stranding records, anecdotal reports, and Navy Marine Mammal Program medical records) to inform an expert elicitation (EE) that developed a probabilistic exposure–response function for survival. From the synthesis, we found abnormalities that ranged from skin lesions, hydropic degeneration of skin, blood abnormalities, cerebral edema, septicemia/endotoxemia, and death. From the medical records of 49 managed care dolphins with low salinity exposures, abnormalities were observed in serum electrolytes (28.5% after 1-13 days) and in skin (35% after 2-38 days). The exposure–response functions derived from the EE indicated that dolphins might endure some periods of exposure to water below salinities of 5 ppt before their health is affected. The experts estimated those periods to be 20–30 days when salinity declined slowly, but only 6–8 days for scenarios where salinity declined more rapidly. Once the survival began to decrease, experts agreed that survival probability would decline rapidly. Although this effort identified many data gaps that will be important to address in the future, the current information that was synthesized will contribute to management decisions such as evaluations of impacts from restoration or construction projects, intervention decisions for stranded or out-of-habitat dolphins, and the development of best management practices. This synthesis was possible through collaborations with researchers and stranding network members across the U.S.

**Lipid composition and trace element associations in blubber from bottlenose dolphins (*Tursiops truncatus*) stranded in the Yucatan Coast**

IxEChel Mariel Ruiz Hernández¹, Reyna Cristina Colli Dulá², Nancy Denslow³, Mohammad-Zaman Nouri³, Marianne Kozuch⁴, RAUL E. DIAZ-GAMBOA⁵, Rossana del Pilar Rodríguez Canul⁶

¹CINVESTAV Unidad Mérida, Mérida, Yucatán, Mexico, ²CONACYT, CINVESTAV Unidad Mérida, Mérida, Yucatán, Mexico, ³Department of Physiological Sciences and Center for Environmental and Human Toxicology, University of Florida, Gainesville, Florida, ⁴Department of Physiological Sciences and Center for Environmental and Human Toxicology, University of Florida, Gainesville, Florida, ⁵Universidad Autonoma de Yucatan, Merida, Yucatan, Mexico, ⁶CINVESTAV UNIDAD MÉRIDA, Mérida, Yucatán, Mexico

Marine species within the coast of Yucatan, Mexico are highly vulnerable to contamination due to the karstic property of the region which allows high permeability of domestic and industrial wastes. Many of these wastes contain trace elements. Essential trace elements can play an important role in metabolism but in high concentrations can be toxic, and non-essential are
very toxic, affecting metabolic pathways and producing alterations in their cellular membrane properties. Different correlation studies had been done to investigate the possible association between trace elements and different biomarkers. Coastal dolphins, (*Tursiops truncatus*), have been used as sentinel species which allows monitoring contaminants since they have blubber that stores high amounts of lipids and contaminants. Lipids are useful bioindicators for contamination because they react to multiple stressors. The aim of this study was to quantify trace elements and characterize the lipidome profile from bottlenose dolphin blubber and to understand biological characteristic relationships and how both are correlated using a lipidomic approach. Trace elements (Cr, Mn, Fe, Co, Cu, Zn, As, Se, Cd) were analyzed by ICP-MS and lipids were measured with LC-MS/MS. Spearman correlation coefficient was used to identify associations between trace elements, lipids and body length. A PLS-DA was performed to discriminate organisms with Cd. The influence of gender, stranding code, stomach content, and growth stage were analyzed with Wilcoxon rank-sum test. Lipid composition was dominated by triacylglycerols. Organisms containing Cd showed lower concentrations of ceramides, triacylglycerols and cholesteryl esters. Trace elements Co, Cr, As and Cd increased with body length. Lipid composition was related to stranding code, stomach content and growth stage. The results provide novel insights about the relationship between lipids and trace elements in blubber from bottlenose dolphin.

**Holocene deglaciation drove rapid genetic diversification of Atlantic walrus**

Emily Johana Ruiz Puerta¹, Xénia Keighley¹, Bastiaan Star Star¹, Sanne Boessenkool¹, Morgan McCarthy², Sean P. A. Desjardins², Liselotte W. Andersen³, Erik Born³, James Barret⁴, Anne Birgitte Gotfredsen⁴, Lesley Howse⁵, Paul Szpak⁶, Snæbjörn Pálsson⁷, Hilmar J. Malmquist⁸, Peter Jordan⁹, Morten Tange Olsen⁹

¹) Arctic Centre & Groningen Institute of Archaeology, Faculty of Arts, University of Groningen. 2) Section for Evolutionary Genomics, GLOBE Institute, University of Copenhagen., Copenhagen, Netherlands, ³Globe Institute, University of Copenhagen, Copenhagen, Denmark, ⁴Greenland Institute of Natural Resources, Copenhagen, Denmark, ⁵McDonal Institute for Archaeological Research, Department of Archaeology, University of Cambridge, ⁶Archeology Centre, University of Toronto, ⁷Peterborough, ⁸Faculty of Life and Environmental Sciences, University of Iceland., Iceland, ⁹Icelandic Museum of Natural History, ¹Arctic Centre & Groningen Institute of Archaeology, Faculty of Arts, University of Groningen, Groningen, Netherlands

Arctic warming is exceeding the global average and predicted to lead to substantial increases in human activities and changes in the abundance and distribution of Arctic species. Mitigating the effects of such changes requires a more detailed understanding of at what level and rapidity organisms responded to environmental change in the past. The Atlantic walrus (*Odobenus rosmarus rosmary*) is closely associated with sea-ice and shallow-water habitats, and is considered an indicator of Arctic ecosystem function and health. Here we analysed 75 ancient and historical Atlantic walrus mitochondrial genomes to provide novel insights on the species’ response to past environmental change. We find that the diversity of Atlantic walruses was strongly shaped by late Pleistocene and Holocene climate fluctuations, surviving in low latitude refugia during the Last Glacial Maximum and all contemporary populations arising during the subsequent Holocene deglaciation. The timing of its high latitude ecologisation fits remarkably well with the known chronology of Holocene deglaciation in the Arctic, indicating that the Atlantic walrus effectvely and rapidly tracked its habitat northward as this became available. Though such a “tabula rasa” hypothesis has been proposed for
some Arctic marine species, others appear to have survived in high-latitude glacial refugia, illustrating the highly interspecific nature of climate-response in the Arctic. Importantly, the relatively rapid mitogenomic diversification and subsequent isolation of the Atlantic walrus in multiple genetically distinct populations indicates that ongoing and future warming may act to further isolate walrus populations and hence increase the species’ vulnerability to human activities.

Live large-whale stranding response in the northern Gulf of Mexico: The importance of preparedness, collaboration, and communication
Mackenzie Russell¹, Jennifer Bloodgood², Cristina Diaz Clark³, Elizabeth Hieb¹, Ruth H. Carmichael¹
¹Dauphin Island Sea Lab/AL Marine Mammal Stranding Network, Dauphin Island, Alabama, ²Dauphin Island Sea Lab, Dauphin Island, Alabama, ³Dauphin Island Sea Lab, Mobile, Alabama, ¹Dauphin Island Sea Lab, ²Dauphin Island Sea Lab/ University of South Alabama, Dauphin Island, Alabama

On 19 November 2020, a live, emaciated, adult male sperm whale (Physeter macrocephalus) was reported stranded inside Mobile Bay, Alabama (AL), USA. This is the first case of a live, large-whale (10.2m) stranded in the state of AL. The case was complicated by its creation of a maritime hazard inside the bay and its extended duration (nine days). During the six days following the initial report, the whale restranded three times, moving up to 32km between stranding locations in the bay. The whale’s location was unknown for up to 36 hours at a time, demanding intensive on-water and aerial search efforts. Due to successful team-based monitoring, on the seventh day, the whale was safely euthanized and relocated to a secure area that enabled a two-day necropsy. During this event, preparedness, collaboration and communication among local, state, federal, and private agencies was key to a successful stranding response. More than ten agencies from multiple states were involved in the response (AL Department of Conservation and Natural Resources, AL Law Enforcement Agency, Dauphin Island Sea Lab, Emerald Coast Wildlife Refuge, Esfeller Construction, GulfWorld Marine Institute, Institute for Marine Mammal Studies, MedVet Mobile, Mississippi State University, Mobile Police Department, National Oceanic and Atmospheric Administration, TowBoatU.S., and U.S. Coast Guard). We found that flexibility during the ever-changing event was important to support team success. For example during monitoring efforts, participant roles were discussed daily, and a debrief was held nightly, with assignments changed as needed considering the rigorous staffing requirements. Communication with the media was maintained and modified throughout the event to respond to ongoing public feedback, including regularly updated press releases, media interviews, and cross-posting vetted information to social media sites. This case emphasizes the importance of network and interagency preparedness and collaboration to facilitate response success.

What is the status of the UK grey seal populations? A question of scale.
Debbie JF Russell, SEA MAMMAL RESEARCH UNIT, UNIVERSITY OF ST ANDREWS, ST ANDREWS, United Kingdom

The UK holds ~40% of the world’s grey seals (Halichoerus grypus). Population trend data are required under national and international legislation. Pup production has been monitored annually at some UK colonies since 1956. Currently, large colonies (c. 90% of UK pup production) are monitored either using ground (c. 10%) or aerial survey (c. 80%) based counts of pups. Multiple surveys are required through a season because single counts represent
an unknown proportion of the total number of pups born. Stage-structured pup counts from multiple surveys are combined with knowledge of life-history parameters to derive birth curves. The resulting pup production estimates are combined with an independent estimate of grey seal population size, within an age-structured, Bayesian population model to produce time series of population estimates for four study regions. The results suggest that three regions (Inner Hebrides, Outer Hebrides and Orkney) have reached carrying capacity, likely mediated through density dependent factors acting on pup survival. The North Sea region is still exhibiting exponential growth potentially, in part, due to immigration from further north; indeed pup production is increasing at c.17% per annum in the southern area. Except in the North Sea, the colony-specific pup production trends show striking variation with few emulating their regional trend. Some long-established colonies, including Special Areas of Conservation, are exhibiting sustained declines. Other nearby colonies have exhibited rapid growth which, at least initially, was driven by recruitment of pups born elsewhere. In some cases, the growth rate slowed, seemingly approaching a carrying capacity, before pup production subsequently declined. The cause of these complex colony-specific dynamics are unclear but demonstrate that there are multiple, scale-dependent factors driving the observed UK population trajectory. The findings also highlight the importance of wide-scale, comprehensive monitoring programs and the potential risks of using indicator sites to develop wider management policies.

Strand Feeding: analyzing a rare and unique feeding behavior by a hyperlocal population of Atlantic bottlenose dolphins (Tursiops truncatus) on Kiawah Island, South Carolina. Lauren Rust¹, Wayne McFee²

¹Lowcountry Marine Mammal Network, North Charleston, SC, ²NOAA, Charleston, South Carolina

“Strand feeding” is a unique hunting behavior in which bottlenose dolphins work together in small groups to herd fish towards the shore. They then use a powerful wave to push the fish onto the shore and then lunge onto the shore to grab the fish. South Carolina and Georgia are the only two locations along the Atlantic coast where this behavior has been documented (Duffy-Echevarria et al. 2008). Captain Sam’s Inlet, located between Kiawah and Seabrook Islands in South Carolina, is a main strand feeding location. Strand feeding can be observed from shore, kayaks and boats, and has become somewhat of a spectacle to onlookers. Disturbance of dolphins while feeding may decrease or stop their normal foraging behavior and cause displacement from preferred habitats. Since 2017, observations of strand feeding have been monitored and documented on a daily basis at this site. We have identified 7 consistent strand feeders who prefer certain areas over others and typically strand feeding in groups of 3. Individual feeding strategies, seasonal variations, and the transference of this behavior between a mother and her calf have been documented. Use of this inlet is greater than initially thought suggesting this inlet is a critical habitat for strand feeding. Additionally, with the increase of onlookers, the dolphins are less likely to strand feed when visitors are closer than 45 feet, thus, affecting the long-term sustainability of this behavior at this location. Long-term photoidentification studies provided by NOAA have allowed us to identify animals with long sighting histories and relationships among offspring and conspecifics. This study has analyzed a specific feeding location for a small population of dolphins and have identified unique feeding strategies lending to an opportunity for conservation of this behavior in South Carolina.
Development of a photo-identification program to estimate abundance of an endangered beluga whale population
Kasey Ryan1, Steven Ferguson2, William R. Koski3, Brent Young4, Jim Roth5, Cortney Watt6
1University of Manitoba, 2Fisheries and Oceans Canada, Winnipeg, Manitoba, 3LGL Limited, King City, Ontario, 4Fisheries and Oceans Canada, Winnipeg, MB, 5University of Manitoba, Winnipeg, Manitoba

The endangered beluga whale population in Cumberland Sound, Nunavut, Canada was commercially exploited for several decades which significantly reduced the population size. The population is currently harvested for subsistence by the local Inuit community of Pangnirtung at a rate of 41 whales landed per year. Though aerial surveys have been conducted intermittently to monitor abundance, further long-term monitoring of the population was needed, and a new photographic-identification (ID) program was developed using unmanned aerial vehicle (UAV) photography. This photo-ID program allows for the estimation of various life-history characteristics and population abundance using capture-mark-recapture techniques. Data have been collected from 2017–2020 using a DJI Phantom 4 UAV. Based on color, size, and proximity to adults, approximately 82% of photographed individuals were classified as adults, 10% as juveniles, 3% as calves-of-the-year, and the remainder were unknown. Approximately 40% of the adult whales were marked with scars, primarily from hunting wounds, that appeared to be unique and likely to persist over time. Previous abundance estimates for the Cumberland Sound beluga population have been based on aerial surveys, and the most recent estimate from 2017 was approximately 1,400 whales. Using capture-mark-recapture abundance estimation techniques based on 21 whales that were resighted over two or more years, the population abundance in 2018 was estimated at less than 600 whales. This estimate is significantly lower than the previous aerial survey estimate, potentially indicating an overcorrection for submerged whales in aerial survey estimates, or strong site fidelity by segments of the population (e.g., males) to specific locations outside the survey area at the time of the UAV survey. Further monitoring of the endangered population using photo-ID will allow us to better understand population dynamics and more accurately estimate abundance, which will ultimately allow for the development of more effective conservation and management strategies.

First Characterization of African Manatee (Trichechus senegalensis) Vocalizations
Athena Rycyk1, Clinton Faucheux2, Eric Angel Ramos3, Beth Brady4, mumi kikuchi5, Hannah Nations6, Karianne Kapfer7, Cecilia Hampton8, Emily Garcia9, Aristide Takoukam Kamla8
1New College of Florida, Sarasota, Florida, 2University of Yaounde 1, Yaounde, Center Region, Cameroon, 3The Graduate Center, City University of New York, BROOKLYN, NY, 4Mote Marine Aquarium, POMPANO BEACH, FL, 5Japan manatee education and study lab, chuo-ku, tokyo, Japan, 6New College of Florida, Sarasota, FL, 7Cornell University, Ithaca, NY, 8African Marine Mammal Conservation, Dizangue, -- Select --, Cameroon

African manatees (Trichechus senegalensis) are difficult to study by traditional visual survey methods because of their elusive nature and the poor water clarity in portions of their distribution. To determine the feasibility of detecting African manatees and investigating their acoustic behavior, we deployed a passive acoustic recorder to sample underwater sounds continuously for two 3-day periods in Lake Ossa, Cameroon. We detected 3,367 manatee vocalizations in 6 days of recordings. A set of high-quality tonal vocalizations (n = 289) characterized for standard acoustic parameters revealed African manatee vocalizations are
similar to those produced by other manatee species. African manatee vocalizations have a fundamental frequency of $4.648 \pm 0.700$ kHz (mean ± SD), a duration of $0.181 \pm 0.069$ s, usually contain harmonics (97%), and sometimes contain subharmonics (21%) or an emphasized band that is not the fundamental band (27%). There was a strong daily pattern in vocalizations, such that vocalizations were most often detected during dusk and at night. We demonstrate that passive acoustic methods can be an important tool to fill the many gaps in our understanding of this data-deficient species.

Balancing lipid and lean store use during reproduction in Weddell seals: Implications for investments in current versus future offspring

Caroline Rzucidlo¹, Amy Kirkham², Jennifer Burns³, Michelle Shero⁴
¹Woods Hole Oceanographic Institution, Massachusetts Institute of Technology, Woods Hole, MA, ²University of Alaska Fairbanks, ³Texas Tech University, Lubbock, Texas, ⁴Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Lactation is energetically-costly, and while it is primarily supported through the breakdown of lipid stores in pinnipeds, females also lose substantial lean mass. Lean stores likely need to be recuperated quickly, as protein loss poses greater health risks and the next pregnancy begins shortly after weaning. This study elucidates the mechanisms governing the balance of lipid versus protein use in female Weddell seals (Leptonychotes weddellii) recovering from lactation (postpartum females) and in females that did not rear offspring (skip-breeders). Body composition (% lipid, lean, total mass), serum insulin, and serum metabolites (glucose; L-amino acids, L-AA; non-esterified fatty acids, NEFA) were measured in prime-age female Weddell seals during the end-lactation period (November/December, n=96) and late-summer during the early pregnancy period (January/February, n=90). Skip-breeders were in better body condition overall with greater mass (p<0.0001) and percent lipid (p<0.0001) than postpartum females. All Weddell seals remained in a state of hypoinsulinemia (88.8±43pg mL⁻¹) across summer, highlighting the importance of consistently promoting lipolysis. At end-lactation, postpartum females had higher NEFA (postpartum=831µM, skip=472µM, p<0.0001) and lower L-AA concentrations than skip-breeders (postpartum=4.04nmol/µL, skip=4.42nmol/µL, p<0.0001), suggesting increased importance of lipid use and protein-sparing during offspring-rearing. Between end-lactation and early-pregnancy, there was a shift in fuel use in postpartum females, as NEFA decreased (from 831µM to 541µM; p<0.0001) while L-AA increased (from 4.04nmol/µL to 4.46nmol/µL; p=0.0126) across summer. Embryo size (measured by ultrasound) during early pregnancy was positively correlated with circulating glucose levels (p=0.0136) and negatively correlated with L-AA (p=0.039), perhaps reflecting increased foraging activity and/or uptake of L-AA to support fetal protein synthesis as pregnancy advanced. Together, results suggest that temporal shifts in lipid and protein store metabolism are important in balancing investment in current and future reproduction.

Using passive acoustic monitoring to find franciscana dolphin (Pontoporia blainvillei) occurrence areas on Uruguayan coast: measures against bycatch

Javier S. Tellechea¹, Sebastian Izquierdo¹, Julieta Delgado¹, Dafni Alfonso¹, Felipe Cordano¹, Sebastian Baubeta¹, Patricia Gonzalez², Agustin Carbonel², Walter Norbis²
¹Facultad de Ciencias, Universidad de la Republica, Montevideo, Facultad de Ciencias, Uruguay, ²Montevideo, Uruguay

Passive acoustic monitoring (PAM) is being used
increasingly to study, survey, and census cetaceans, many of which are easier to hear than to see. Due to its small size, color, and rare aerial displays it is difficult to study the franciscana dolphin (*Pontoporia blainvillei*) in the wild. The franciscana dolphin is endemic to the Southwestern Atlantic Ocean (from Itaúnas, Brazil to Península Valdes, Argentina) and is classified as Vulnerable by the International Union for Conservation of Nature (IUCN). Throughout the Uruguayan coast, it is estimated that more than 500 franciscana dolphins die in artisanal and industrial fishing nets per year. In fact, most of our information on this species has been collected from individuals caught in fishing nets and PAM studies in our country. Therefore, PAM is ideal for surveying and studying this elusive species. Our main objective is to detect the presence of this dolphin in the Uruguayan coast, both spatially and temporally by acoustic means of passive listening during a two-year period (2021-2022). All of this by means of using five PAM stations (sampling rate = 192 kHz) that can record continuously for 95 hours. It was possible to detect several areas of occurrence for this species; some of these areas are novel for this dolphin in the Uruguayan coast. In addition, new characteristics of acoustic data for this species were obtained. These results are preliminary, as there is funding for one more year for continuous and seasonal sampling of this endangered species. Our study is a novel method that has never been applied for this species throughout its entire distribution. It is aimed at changing the focal point towards conservation and protection of the franciscana dolphin residence areas, found through PAM stations.

Regulatory Evolution of the Myoglobin Gene: A Comparison of the Human Gene with the Minke Whale, *Balaenoptera acutorostrata*

Charles Sackerson¹, Vivian Garcia¹, Jessica Maldonado², Nicole Villasenor¹, Rachel Cartwright³

¹California State University Channel Islands, ²California State University Northridge, ³The Keiki Kohola Project, Delray Beach, FL

Cetaceans have undergone numerous adaptations to their aquatic environment, including the ability to dive to great depths and remain submerged for extended periods. Among the cell and molecular adaptations that enable this behavior is a high level of myoglobin, an intracellular oxygen carrying protein expressed in skeletal muscle, presumably to provide the oxygen required for extended dives. Since transcription of genomic DNA sequence to mRNA can be a primary determinant of protein levels, we hypothesized that the myoglobin gene of minke whales, *Balaenoptera acutorostrata*, would be transcriptionally more active than that of terrestrial mammals such as humans. Unexpectedly, we find that the minke whale gene displays one eighth the activity of the human gene when expressed in differentiated C2C12 mouse myoblast cells; expression levels are similar to that of cows, and less than 2% that of horses. Despite the limitations of assays in cultured cells, a direct comparison of the human and whale promoter in these cells allows evolved regulatory differences to be identified. We have dissected the minke whale promoter and find: (1) Whale homologs of the human regulatory elements previously identified by others are not highly active in the minke whale gene. (2) There is a general conservation of the transcriptional machinery, such as muscle-specific E-box binding proteins and SP1. (3) Bioinformatics analysis predicts that the lower activity of the minke whale gene may result from a lower number and density of DNA binding sites for critical transcriptional activators than in humans. We will present bioinformatic evidence for possible upstream enhancers that may operate to increase the whale gene’s activity while diving. Last, we will reference post-transcriptional mechanisms identified in other systems that may be responsible for the high myoglobin protein levels seen in Cetacea.
Survey and characterization of selected emerging viral agents and potentially associated with hepatopathies in cetaceans, Brazil

Carlos Sacristán¹, Ana Carolin Ewbank², Aricia Duarte-Benvenuto², Pedro Navas-Suárez³, Roberta Zamana-Ramblas³, Irene Sacristán⁴, Samira Costa-Silva⁵, Vanessa Lanes Ribeiro⁶, Rodrigo Valle⁷, Pedro Castilho⁸, Adriana C. Colosío⁹, Milton Marcondes¹⁰, Vitor Carvalho Luz¹¹, Caroline Pessi¹², José Luiz Catao-Dias¹³
¹University of Sao Paulo, BRAZIL, SAO PAULO, Brazil, ²School of Veterinary Medicine and Animal Sciences – University of Sao Paolo., Sao Paulo, Sao Paulo, Brazil, ³Faculdade de Medicina veterinária e Zootecnia - FMVZ - USP, Sao Paulo, Sao Paulo, Brazil, ⁴Centre for Animal Health Research (CISA), National Institute of Agricultural and Food Research and Technology (INIA), Valdeolmos, Madrid, Spain. Spanish National Research Council (CSIC), Madrid, Spain., Sao Paulo, Sao Paulo, Spain, ⁵Faculdade de Medicina Veterinária e Zootecnia-FMVZ-USP, Departamento de Epidemiologia Aplicada a Zoonoses, Brazil, ⁶Instituto Biopesca, Praia Grande, Brazil, ⁷Biopesca Institute, Paulista University, Santos, Sao Paulo, Brazil, ⁸Universidade do Estado de Santa Catarina, Laguna, Brazil, ⁹Instituto Baleia Jubarte, Caravelas, Bahia, Brazil, ¹⁰Instituto Baleia Jubarte, Caravelas, Bahia, Brazil, ¹¹AQUASIS, Caucaia, Ceará, Brazil, ¹²Instituto de Pesquisas Cananéia (IpeC), Cananéia, São Paulo, Brazil, ¹³School of Veterinary Medicine and Animal Science, University of Sao Paulo, Sao Paulo, Brazil

Hepatic lesions are classified as relevant and relatively common in cetaceans. Nevertheless, their etiology remains mostly unknown. In mammals, different viruses have been described as etiologic agents of liver damage, including herpesviruses (HV), adenoviruses and hepatitis E virus (HEV) – the latter with some zoonotic genotypes. These three viruses have already been detected in cetaceans, and are considered emerging agents. Herein, we isolated DNA and RNA from 181 and 138 cetacean liver samples, respectively. DNA samples belonged to the families Delphinidae (n=105), Balaenopteridae (n=34), Kogiidae (n=19), Physeteridae (n=3), Balaenidae (n=1), and Ziphiidae (n=2), while RNA extractions belonged to Delphinidae (n=71), Kogiidae (n=34), Physeteridae (n=19), Kogiidae (n=17), and Ziphiidae (n=2). DNA samples were tested for HV with a pan-PCR protocol and a specific gammaherpesvirus protocol, and for adenovirus with a pan-PCR protocol. RNA samples were tested for HEV by rt-PCR. Statistical analyses were performed to assess if the occurrence of herpesvirus infection could be predicted by the following individual variables: species distribution (coastal, pelagic or mixed habitat), sex (male, female), age group (calf, juvenile, adult) and family (in those with more than ten individuals). Overall, 8 of 181 (4.4%) cetaceans were HV-positive: one Guiana dolphin (Sotalia guianensis) and one dwarf sperm whale (Kogia sima) were infected with alphaherpesviruses, while five franciscanas (Pontoporia blainvillei) and one pygmy sperm whale (Kogia breviceps) had gammaherpesviruses. HV-prevalence was statistically significant higher in Pontoporiidae when compared to Delphinidae. All the samples were negative to adenovirus and HEV. This is the first report of herpesviruses in pygmy sperm whales, tentatively named Kogiid gammaherpesvirus 3. Our study expands the knowledge on the presence of herpesvirus in cetacean liver samples, a tissue with few previous descriptions of this agent. Ongoing studies will evaluate histopathologically the HV-positive cases to further characterize our findings. Funding: FAPESP#2018/25069-7 and CAPES.
Evaluating population metrics at the Piedras Blancas northern elephant seal breeding colony from 2018-2021: Is the population approaching carrying capacity?
Katie Saenger¹, Michael Tillman², Tyler Peck-Burnett³, Kate Riordan¹, Catie Halvorsen³, Bryce King⁴, Emma Weitzner⁵, Melissa Voisinet⁷, Cameron Cooper³, Rachel Holser⁴, Claire Nasr⁹, Patrick Robinson¹⁰, Heather Liwanag¹¹
¹California Polytechnic State University; San Luis Obispo, San Luis Obispo, CA, ²The Marine Mammal Center, San Luis Obispo, CA, ³California Polytechnic State University San Luis Obispo, ⁴California Polytechnic State University - San Luis Obispo, San Luis Obispo, CA, ⁵California Polytechnic State University; San Luis Obispo, ⁶California Polytechnic State University, ⁷CUNY Graduate Center, New York, New York, ⁸University of California, Santa Cruz, Santa Cruz, CA, ⁹University of California, Santa Cruz, ¹⁰Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, ¹¹California Polytechnic State University, San Luis Obispo, California

The northern elephant seal (Mirounga angustirostris), nearly driven to extinction in the 19th century, has made an incredible recovery in the last century and now ranges from Mexico to Oregon. The Piedras Blancas (PB) breeding colony in San Simeon, CA is the largest mainland colony for the species. As of 2018, the estimated population size at PB was 26,000, with almost 6,000 pups born annually. Despite the large size of this colony, however, it has not yet reached carrying capacity, resulting in an increasing population and continual expansion of seals to different beaches along the central California coast. In this study, we analyzed population metrics at the PB colony from the 2018, 2019, 2020, and 2021 breeding seasons to determine whether this population is approaching carrying capacity. Metrics included number of seals by age class, as well as weanling mass and morphometrics. Our results suggest there may be an increase in the total number of seals present at PB during the breeding season (December-March) from 2018-2021, but not during the molting season (April-July). More specifically, we found there was an increase in the total number of females at two of the most recently established rookery beach sites, and a potential decrease in the total number of females at more established beach sites from 2018-2021. We also found no significant difference in weanling weights across years at PB (P=0.966, F=0.002). Our results suggest that PB has not yet approached carrying capacity; however, further research needs to be conducted to substantiate this conclusion. We plan to compare these metrics to those at a colony that has reached carrying capacity, Año Nuevo. Understanding the population growth at PB is important for informing management decisions at this colony, as the breeding beaches are very accessible and interactions with the public are becoming increasingly problematic.
2013 and 2020. The NOAA Fisheries (NMFS) West Coast Regional Office (WCR) staff reviewed these cases with hopes to understand the origins and evolution of entanglements to inform the development of actions to address the concern about increasing entanglements on the U.S. West Coast in recent years. "Forensic analysis" refers to extensive evaluation of all available documents for various characteristics or attributes of entanglement reports, including the type of gear involved, the configuration of entanglement on the animal, and any additional information that could be helpful for various stakeholder interests including rescue, management actions, or research. Our analysis includes review of gear origin (buoys, gear set location), gear identification (buoy ID, gear tags) and gear configuration (commonality and variance by fishery and whale species) associated with recent U.S. West Coast whale entanglements. Recognizing that there are still many unknowns in understanding the dynamics of entanglements, the outcomes of the forensic analysis have improved the understanding of the interactions between gear and large whales along the U.S. west coast to guide future actions to prevent entanglements.

Observations of flipper rubbing in mother-calf pairs of captive bottlenose dolphins (Tursiops truncatus) suggest a body surface care function

Mai Sakai1, Hiroshi Katsumata2, Shiro Koshima3
1Kindai University, Nara, Japan, 2Kamogawa Sea World, Kamogawa, Japan, 3Wildlife Research Center of Kyoto University, Kyoto, Japan

Pairs of bottlenose dolphins perform a social behavior called flipper rubbing, in which they rub their partners with their pectoral fins. This is similar to social grooming in primates, which has been speculated to have both social and hygienic functions. In recent years, it has been suggested that flipper rubbing in bottlenose dolphins has social functions, including reconciliation; however, there are no reports based on quantitative data to support the hygienic function of this behavior. In this study, flipper rubbing and self-rubbing (a dolphin rubs itself with the object such as floor or wall of a tank) was observed in a group of captive bottlenose dolphins consisting of three mother-calf pairs. The results showed that in 18% of the 859 flipper rubbing episodes and 54% of the 277 self-rubbing episodes observed, dead skin was shed from the rubbed body part. In addition, there was a significant negative correlation between the number of episodes the subjects received flipper rubbing and the number of episodes the subjects performed self-rubbing (P<0.05). These results suggest that flipper rubbing behavior has a hygienic function, particularly to care for the body surface. In all the three mother-calf pairs, the mother rubbed her calf significantly more often than the calf rubbed the mother(P<0.05), and each mother became a rubber significantly more often when their own offspring was their rubbing partner than when the partner was any other individual(P<0.05). These findings suggest that flipper rubbing is one of the mother-to-calf caring behaviors exhibited by bottlenose dolphins.

Testing marginal value theorem predictions with diving animals foraging on mesopelagic prey, lactating northern fur seals

Yuta Sakuragi1, Vladimir Burkanov2, Russel Andrews3, Yoko Mitani4
1Hokkaido University, Hakodate, Hokkaido, Japan, 2Marine Mammal Laboratory, AFSC, NMFS, NOAA, Seattle, Washington, 3Marine Ecology and Telemetry Research, Kingston, WA, 4Kyoto University, Hokkaido, Japan

The marginal value theorem (MVT) predicts the efficient foraging behavior of animals when their prey is distributed in a hierarchical patch structure. For diving animals, MVT predicts that prey capture rate will have opposite effects on patch residence time, increasing with prey...
capture rate on the short-term (single dive) scale, but decreasing with prey capture rate at the longer-term (dive bout) scale. Lactating northern fur seals (Callorhinus ursinus, NFS) often feed nocturnally on patchily distributed mesopelagic species, so we tested the hypothesis that NFS would follow the predictions of the MVT. In 2006, six lactating NFS were instrumented with GPS and 3D movement data loggers, which were recovered after 1-3 foraging trips. From acceleration data, we interpreted vertical turns (VT) as a prey encounter index. We examined how prey encounter rate varied with time in each dive (diminishing or increasing return), and whether dive duration (as patch residence time) increased with VT rate in the dive and decreased with VT rate in the bout by using Linear Mixed Effect Models (LME). The highest proportion of dives (0.57 ± 0.05) had a diminishing return of VT rate. LME showed that dive duration was negatively related to dive-scale VT rate, but that bout-scale VT rate was not a significant factor. Unlike some other diving species, these NFS did not follow the predictions of MVT, perhaps because the MVT assumptions were not valid. The timing of VTs in some dives suggested that NFS may have foraged on multiple small prey patches within a single dive and at other times they may have fed on solitary prey or low-density patches. Therefore, judging the optimality of a diver’s behavior may require additional information on the distribution, density and behavior of their prey species.

Dominance in breeding female northern elephant seals (Mirounga angustirostris)
Elena Salogni1, Edward H. Miller2
1Memorial University of Newfoundland, Italy, 2Memorial University of Newfoundland, St. John’s

Dominance is a core aspect of animals living or breeding in a social group. Among species great variation is present in frequency and type of interactions, and orderliness. In both species of elephant seal (Mirounga), dominance has been studied mostly in adult males. Little information is present on breeding females, whose dominance can affect their ability to protect both the pup and a space around the pair to minimize separations and aggressive interactions. A few studies on the northern elephant seal (M. angustirostris) have claimed that dominance relationships among females exist and affect reproductive success. Those studies were based on small samples of individuals and did not analyze dominance quantitatively. We quantified orderliness and steepness of dominance relationships among adult female northern elephant seals during the 2007-08 breeding season at Isla San Benito Medio, in Baja California, Mexico. We analyzed dominance structure in six harems, varying in size from 16 to 254 females, at the peak of the breeding season. We observed 2249 interactions among 303 females and obtained 1268 closed triads. We calculated orderliness using both the modified linearity index and triangle transitivity, and inferred hierarchy steepness using randomized Elo-rating repeatability. We observed moderate to high values of sparseness. The modified linearity index varied from 0.02 to 0.49. Excluding one harem with only 10 closed triads, triangle transitivity varied from 0.29 to 0.89 and randomized Elo-rating repeatability varied from 0.78 to 0.91. Our findings indicate the presence of unstable to moderate hierarchies and intermediate values of steepness. This new information about dominance structure may help our understanding of the impact of social environment on the reproductive success of females.

Life at the borderline: Ganges river dolphin responses to canal-river dry-season flow regulation by the Farakka barrage, India.
Imran Samad1, Nachiket Kelkar2, Jagdish Krishnaswamy3
1Indian Institute of Science, Bengaluru, Karnataka, India, 2Ashoka Trust for Research in Ecology and the Environment, Bengaluru,
Modification of rivers by barrages has fragmented riverine habitats and threatened the survival of Indian sub-continental river dolphins by altering river flow and depth characteristics needed for their survival. In this study, we assessed habitat use dynamics of endangered Ganges river dolphins in response to dry-season operations of the Farakka barrage on the Ganga river located 25 km upstream of the Indo-Bangladesh border. We conducted 10 surveys in i) the Ganga river below the barrage (14 km), where rapid changes in water levels were expected, and ii) a narrow water diversion feeder canal (36 km) where we expected stable water levels. In all surveys, we recorded dolphin distribution, water depth, and temperature, and analysed dolphin occurrence data in a dynamic occupancy modelling framework. We also estimated temporal trends in a) river discharge, b) primary productivity and c) fish availability, to explain observed river dolphin responses. We found that colonization in all stretches increased with rising temperatures and increasing fishing intensity, which was likely a response to the upstream migration of an anadromous fish - the Hilsa. Deep river pools provided important habitats for dolphins as discharge decreased, while the canal appeared to provide a stable hydrologic refuge. However, increased colonization by dolphins resulted in a greater risk of bycatch in fishing nets, making the canal an ‘ecological trap’. Primary productivity dynamics were not impacted by barrage operations and neither was it linked to shifts in fish catch and availability at shorter timescales. Our results highlight the need for the inclusion of ecological flow criteria and fishery regulation in transboundary river sharing and management, while also providing evidence to evaluate current and future water-sharing agreements within the country.

Niche partitioning among four species of odontocetes in Iceland: harbour porpoises (Phocoena phocoena), white-beaked dolphins (Lagenorhynchus albirostris), long-finned pilot whales (Globicephala melas) and killer whales (Orcinus orca)

Filipa Samarra1, Asunción Borrell2, Alex Aguilar3, Gisli Vikingsson4
1University of Iceland, Vestmannaeyjar, Iceland, 2Universitat de Barcelona, Barcelona, Spain, 3University of Barcelona, Barcelona, Spain, 4Marine and Freshwater Research Institute, Hafnarfjörður, Iceland

Niche partitioning among sympatric species occurs to decrease competition for resources. Here, we investigate the feeding ecology of four of the most common odontocetes occurring in Iceland: harbour porpoises (HP), white-beaked dolphins (WBD), long-finned pilot (PW) and killer whales (KW). Using stranding, bycatch and/or biopsy samples spanning approximately 30 years we investigate within and between species differences in stable isotopic signatures of carbon and nitrogen in relation to year of sampling, length, sex, age class and differences between stranded and bycatch/biopsy samples. We find evidence of niche segregation but also some extent of overlap between species, suggesting that largely these species avoid competition by either targeting different resources or by possibly consuming the same resource in different proportions. Temporal trends in carbon isotopic signatures indicative of the Suess effect are observed but the rate of change through time varies with species. Changes in nitrogen isotopic signatures between age classes are observed, including a decrease from calves to juveniles and in some cases an increase as juveniles mature into adults, such as in HP. In PW, nitrogen isotopic signatures appeared to decrease with year of sampling suggesting possible changes in diet. WBD stranded samples showed higher carbon and nitrogen isotope ratios than bycaught samples, suggesting bycatch targets dolphins with a diet...
that is not representative of the whole population or, alternatively, that stranded individuals were under nutritional stress or poor health condition. In KW, the only species for which biopsy samples were available, within-population variation in isotopic niche relates to known differences in behavioural patterns, highlighting the value of using tissue samples from free-ranging individuals and complementing stable isotope analyses with observations of individual behaviour. This study provides the first integrated assessment of odontocete feeding ecology in Iceland, which will contribute to measure the effects of future environmental changes.

Spatial and temporal characterization of the exposure of island-associated cetacean populations to whale-watching in a remote oceanic island (NE Atlantic)

Annalisa Sambolino¹, Filipe Alves², Marc Fernandez Morron¹, Anja Badenas³, Rita Ferreira³, Ana Dinis⁶

¹MARE - Marine and Environmental Sciences Centre / ARDITI, University of Madeira, Funchal, Madeira, Portugal, Portugal, ²MARE - Marine and Environmental Sciences Centre, Portugal, ³Universidade dos Açores, Ponta delgada, Azores, Portugal, ⁴MARE- Marine and Environmental Sciences Centre, Funchal, Portugal, ⁵MARE-Madeira, Portugal, ⁶MARE/ARDITI/OOM, Funchal, Portugal

Identifying and quantifying individual repeated exposure of whales and dolphins to wildlife tourism is essential to address proper management actions. This is especially relevant in touristic regions where cetacean communities show high site-fidelity, as it is the case for common bottlenose dolphins (Tursiops truncatus) and short-finned pilot whales (Globicephala macrorhynchus) in Madeira Island. In the present study, we used 13 years of photographic identification data collected on whale-watching (WW) vessels between 2003-2016 to assess individual patterns of exposure of these two cetacean populations to the whale-watching activity and identify the most vulnerable individuals, i.e. the island-associated individuals showing most recurrent interactions. We then characterized the spatial and temporal variation of the WW activity in the study area by compiling GPS positions of cetacean-boat interactions recorded between 2003-2018 and visual counts of WW vessels collected between 2014-2017. Lastly, we determined the most relevant months and sites of interactions for these island-associated individuals. From a total of 367 bottlenose dolphins and 536 pilot whales identified, a minimum of 6% and 10%, respectively, were found to be prone to long-term recurrent exposure. Sightings from whale-watching vessels mainly occurred in ca 1500 km² off Southern Madeira Island; Kernel density estimation (50%) revealed two main core sites of interactions off the capital city of Funchal. A daily average of 6.5 (±0.1 SE) vessels were recorded in this core area, with a peak of 13 during summer, which may represent a critical season especially for island-associated pilot whales individuals. The present study highlights the importance of using opportunistic data to investigate anthropogenic stressors, as tourism-based cetacean observation. It also provides a first characterization of whale-watching pressure in Madeira Island and calls attention to the need of monitoring the fitness and well-being of these island-associated cetacean populations.

Bycatch estimation of South American sea lions (Otaria byronia) in common hake industrial trawl fishery at central south of Chile

Marcelo San Martín¹, Claudio Bernal², Christian Vargas², Juan Carlos Saavedra-Nievas³, José López³

¹Instituto de Fomento Pesquero, Viña del Mar, Chile, ²Instituto de Fomento Pesquero, Valparaiso, Chile, ³IFOP, Valparaiso, Chile, ⁴Instituto de Fomento Pesquero, Valparaiso, Chile, ⁵Valparaíso, Chile
Fisheries bycatch of marine mammals is a worldwide problem and unfortunately has been exacerbated due to drastic declines in population abundances of several species. Many RFMOs and countries have taken actions to afford this issue and Chile is no exception. Since 2013 Chile developing permanent monitoring programs to register bycatch and discards through observers on board. Considering records and operational information obtained between 2015 and 2020 years, this work evaluates the South American sea lions (Otaria byronia) bycatch in common hake (Merluccius gayi) industrial trawl fishery, a most important demersal fishery of central south of Chile. Two industrial trawling fleets were assessed, a fleet characterized by small vessels (<22 m length) or smaller fleet, located between 33°S and 34°S; and other compound by large vessel (until 55 m) or larger fleet, which operate from 34°S to 40°S. The number of sea lions bycatch were estimating through a ratio estimator, using the total catch as an auxiliary variable. The results showed that smaller fleet had the highest bycatch of sea lions, with a average annual of 168 individuals captured in the period evaluated, compared with the 69 estimated in the larger fleet. Conversely, the mortality proportion was higher in larger fleet, reaches an 84% versus 75% in smaller fleet. The proximity to the coast of fishing operation of fleets, especially the smaller, presence of important colonies of sea lions in the area and discards provoked by fishery, could be the most important factors of bycatch. Despite high levels of bycatch, mitigation measure as bycatch reduction device (rigid separation grid) applied by users in the last years, have contributed to reduce significantly its. This results give important information about the historical impact of hake fishery, allowing to improve the Chilean fisheries management and conservation of South American sea lions.

Bycatch hotspots of mature female franciscana dolphins (Pontoporia blainvillei) in the southern Brazilian coast
Jéssica San Martins Fonseca¹, Danielle Monteiro¹, Eduardo Secchi², Tiago Gandra³, Silvina Botta⁴

Franciscana bycatch in gillnet fisheries has been high for the last 60 years. It is considered the most endangered small cetacean in the Southwestern Atlantic Ocean. Previous fisheries management regulations in southern Brazil did not cover areas of higher risk of bycatch. In this work, we aim to identify bycatch hotspots of mature female franciscanas due to their higher biological value. We used data on gillnet fishing trips obtained from logbooks and onboard observers. Data included location, date, sex, and reproductive status of franciscanas bycaught. Prior to the mid-1990s, the location was approximate and based on land reference points and depth. For this dataset, the area covered by a trip was estimated by crossing the latitudinal polygon (defined by land reference points) and the GEBCO bathymetric model reclassified by the depth range reported by fisherman. All trip polygons were aggregated to a 0.1°grid layer, by counting the number of trips and the proportional intersection area between grids and trip polygons. For the data with coordinates, points distribution was outlined with a kernel density heatmap using a 10000m bandwidth. Adult females’ hotspots can be identified when comparing with the total bycatch area. The heatmap points to two density sites, one to the north and the other to the south of the fishing area. The proportional area map indicated three hotspots, two of which coincided with the heatmap area, and the other is located farther
from the coast in the northern part. We recommend that these hotspots of mature female franciscana bycatch should be prioritized as no-fishing zones to improve the effectiveness of the current management measures and the chances of franciscana long-term survival.

First estimates on abundance and habitat use of Risso's dolphins (Grampus griseus) in the Balearic Islands, and considerations on the applicability of their monitoring for local MPAs

Alexander Sánchez Jones¹, Ricardo Sagarminaga², Ignacio Liano³
¹Proyecto Alnitak, Vejer de la Frontera, Cadiz, Spain, ²Madrid, Spain, ³Alnitak, Spain

The effective and long-term monitoring of deep water cetacean populations is regularly deemed inviable due to economic or logistical impasses. However, finding ways to conduct these types of studies may be increasingly important for understanding these species and their offshore habitat. Alnitak’s ongoing work monitoring MPAs around the Balearic Islands puts the organisation in a unique position to take on the study of a cetacean population that 1) can only be encountered offshore, 2) uses habitats included inside a deep-water MPA and 3) is a species still considered to be Data Deficient (IUCN) in the Mediterranean Sea: the Risso’s dolphin (Grampus griseus). This poster presentation shares a first estimate of abundance around the Balearics as well as notes on habitat use inside MPAs such as Cabrera Archipelago National Park and other observations made between 2018-2021, with the support of data collected since 2011.

Net Removal Operations In Support Of Vaquita Recovery Strategies: A Summary Of Six Years Effort

Laura Sánchez-Alòs¹, Eva Carolina Hidalgo Pla², Lorenzo Rojas-Bracho³, Gustavo Cárdenas Hinojosa⁴, Andrea Bonilla-Garzón⁵, Armando Jaramillo-Legorreta⁴, Diego Ruiz Sabio⁴, Carlos Samudio⁶
¹Sea Shepherd Conservation Society, Santa Coloma de Gramenet, Cataluña, Spain, ²Scripps Institution of Oceanography, La Jolla, CA, ³Ocean Wise, Ensenada, Baja California, Mexico, ⁴Comision Nacional de Areas Naturales Protegidas, Ensenada, Baja California, Mexico, ⁵Sea Shepherd Conservation Society, ⁶Comision Nacional de Areas Naturales Protegidas - SEMARNAT, Ensenada, Baja California, Mexico, ⁷Museo de la Ballena y Ciencias del Mar, ⁸Pesca ABC

The vaquita porpoise (Phocoena sinus) population size was estimated to be at less than 20 individuals in summer 2018. Incidental entanglement in gillnets for shrimp and finfish, particulary in recent years by the resurgence of the Totoaba (Totoaba macdonaldi) fishery, fueled by the lucrative illegal trade for their swim bladders, is in the last decade the main cause of vaquita dramatic population decline. Despite a ban on the use of gillnets placed by the Government of Mexico in 2015, and extensive enforcement efforts, illegal nets continue to exist within the range of the critically endangered vaquita. Bycatch of other species of marine mammals, turtles, sharks, fish and invertebrates also occurs in the area.

The removal of gillnets from their habitat is considered as one of the most urgent actions to prevent the extinction of vaquitas. Started by Sea Shepherd's Operation Milagro in collaboration with the Mexican Navy in 2015, the net removal efforts were expanded between 2016-2020 by an interinstitutional program under the lead of the Ministry of Environment (SEMARNAT). The program included Museo de la Ballena y Ciencias del Mar, other agencies of the Government of Mexico, WWF-Mexico, PRONATURA and very importantly fisherman's organization PESCA ABC and Cooperativa Islas del Golfo. Since the start of the program, more than 1,482 entangling nets have been removed
from the vaquita habitat through these collaborative efforts. Here we report the net removal efforts in the area of the Vaquita Refuge (established in 2005). This area is the main focus of the program, as is where the highest density of vaquitas is estimated to occur, based in acoustic detection and visual surveys. As ancillary data we have made counts of fishing boats inside the Refuge, where it is forbidden any fishing activity, which indicates the continued presence of the illegal activity.

Aerial visual acuity of harbor seals (Phoca vitulina) for stationary and moving single targets
Laura-Marie Sandow¹, Frederike Hanke²
¹Institute for Biosciences, Neuroethology (University of Rostock), Rostock, Mecklenburg Western Pomerania, Germany, ²University of Rostock, Germany

Harbor seals (Phoca vitulina) need to detect single targets such as when orienting with respect to landmarks or stars or when hunting prey. Moreover, some years ago, it was hypothesized that the seals’ ability to perceive optic flow could allow them to analyze optic flow induced by moving through turbid waters. Thus even single targets as small as particles dissolved in the water column might be important for a seal. Therefore, it is interesting to know, how large single objects or particles must be to be detected by the animals. In this study, we set out to assess the aerial single target acuity for stationary and moving dark dots with varying contrast to a white background in two male harbor seals. In a two-alternative-forced-choice discrimination task, the seals, positioned at a 60 cm-distance to the presentation monitor, had to indicate whether the single target was either presented on the left or right side of the monitor. The experiment was conducted under constant ambient illumination. Single target acuity for high contrast (Weber contrast = 0.97) stationary targets was determined as 0.31 ± 0.03 deg (N=2). When the contrast of target to background was lowered, single target acuity only slightly decreased finally reaching 0.35 ± 0.03 deg (N=2) for a Weber contrast of 0.22. Single target acuity for high contrast moving targets amounted to 0.27 ± 0.05 deg (N=2) and again slightly decreased the lower the contrast. Thus neither contrast nor motion had a significant impact on single target acuity. The single target acuity however is lower than the grating acuity of harbor seals which can probably be explained by their rather low contrast sensitivity.

Synchronous Acoustic and Visual Monitoring of Sotalia guianensis Fishing Behaviors at Beach Slopes in Comprida Island, São Paulo, Brazil
Lucas Santos¹, Mario Manoel Rollo²
¹São Paulo State University (UNESP); Instituto Baleia Jubarte (IBJ/Brazil), Brazil, ²Vibroacoustics and Geospatial Ecology Lab (IAPETUS), Biosciences Institute, São Paulo State University, Coastal Campus, São Vicente, São Paulo, Brazil

Recent technological advances related to Unmanned Aerial Vehicles (UAVs) allowed researchers to study wild animals in their natural habitats from a better perspective and in a less invasive way. In the south of Comprida Island, located in the southeastern part of São Paulo State, Brazil (25.05ºS, 47.91ºW), individuals of Guiana dolphins Sotalia guianensis conduct complex fishing behaviors on the beach slope areas associated with fixed artisanal fishing enclosures. In order to understand the relationship between the vocalizations produced by delphinids and the behavioral contexts in which they occur naturally, we analyzed data from those events. The acoustic variations of vocalizations produced during two fishing behaviors (pursuit and pursuit with bubbles) were investigated using non-invasive techniques that combine the use of passive acoustic monitoring systems and aerial video recording from a UAV
to collect both acoustic and visual data of dolphins under natural conditions. We documented specific intervals of time that represent phases of the two fishing behaviors and characterized the acoustic signals produced in each one of them. A total of 50m:46s synchronous monitoring was recorded over 3 days of fieldwork conducted between 6 and 8 November 2020, resulting in 14 behavioral events and 220 vocalizations produced. We found significant differences in the minimum and maximum frequencies and in the duration of the whistles between the two analyzed behaviors (p <0.05). This study presents evidence of how the modulation of whistles can be associated with foraging behaviors performed by individuals of *Sotalia guianensis* from the Comprida Island population and suggests that these behaviors can be related to site fidelity and cultural transmission. We point out the importance of acoustic characterization as a tool for studies of passive acoustic monitoring and for conservation efforts and propose the use of the method presented here on cetacean’s behavior and acoustic studies.

**Is there good news for harbour porpoises in Polish waters?**

*Joanna Sarnocinska-Kot¹, Marta Aninowska², Olga Brocławik², Frank Thomsen¹*

¹DHI Polska Sp. z o.o., Warszawa, Warszawa, Poland, ²DHI Polska, Warszawa, Poland, ¹DHI, Hørsholm, Denmark

Harbour porpoises (*Phocoena phocoena*) are endangered in the Baltic Sea with only between 80 – and 1,100 individuals left, based on a large scale passive acoustic monitoring (PAM) study undertaken between 2011 and 2013 (SAMBAH study). Based on SAMBAH, porpoise numbers in Polish waters were thought to be extremely low even for Baltic Sea standards. We previously reported an increase of porpoises compared to the SAMBAH study in two small areas within Polish waters. In the current study, we investigated trends in harbour porpoise occurrence using data from six dedicated PAM projects covering a much wider study area and many more years (2012 – 2021) than previously. We compared our findings on proportion of detection positive days (% DPD) with the SAMBAH results. The results of our study confirm that the number of detections of harbour porpoises was much higher compared to SAMBAH, indicating a much higher number of animals present in more recent years. These findings could indicate a larger scale shift of harbour porpoises into the East of the Baltic. They could also point to a general increase of porpoises in the Baltic Sea. Yet, future investigations covering more areas of the Baltic and possibly including methods to follow individuals are necessary to conclude on trends in harbour porpoise abundance in Polish waters and in fact the entire Baltic.

**Winter sightings of humpback whales (Megaptera novaeangliae) on a feeding ground of the West Antarctic Peninsula**

*Oksana Savenko¹, Vadym Tkachenko²*

¹National Antarctic Scientific Center / Ukrainian Scientific Center of Ecology of the Sea, Odesa, Ukraine, ²National Antarctic Scientific Center of Ukraine, Melitopol, Zaporozhye, Ukraine

Humpback whales (HW) use waters around the Antarctic Peninsula as the feeding areas in summer. They perform long annual migrations to low latitude breeding grounds in winter. However, still little is known about their winter distribution in the Antarctic. To reveal the HW presence in the waters of the West Antarctic Peninsula during late autumn, winter, and early spring, year-round monitoring was conducted at the Ukrainian Antarctic Akademik Vernadsky Station (Argentine Islands) in 2021. There were 62 boat surveys of the 1032 nautical miles of total length conducted from May to September: 10-14 cruises every month on days when ice conditions were acceptable. The main study
locations were waters of the Wilhelm Archipelago and its adjacent area: Penola Strait and French Passage, Petermann, Vedel, and Hovgaard Islands. During the boat surveys, 159 groups and single individuals of HW have encountered: 62 sightings in May, 75 in June, and 22 in July. The group sizes ranged from 1-4 (Med=2), and 11% of the groups included calves. The primary behavior observed was feeding. HWs were predominantly using the area between Peterman, Hovgaard, and Vedel Islands. The last HW encounter happened on July 26. Our results indicate the late winter presence of feeding HW in the region in 2021. It is known that krill move inshore during winter and it is very likely that the whales were taking advantage of ice-free areas during the first two months of the winter to prolong feeding before their migration to the breeding grounds. The shift in the timing of seasonal migration should be properly monitored to better understand the impacts of changing conditions.

**Bottlenose Dolphins Respond Differentially to Social Versus Non-Social Video Stimuli**

Jennifer Savoie1, Marcelo Magnasco2, Diana Reiss3

1Graduate Center City University of New York, Stamford, CT, 2The Rockefeller University, New York, NY, 3Hunter College, New York, New York

We investigated if dolphins would respond differentially to videos of social versus non-social stimuli. Two, captive-born, male bottlenose dolphins (Tursiops truncatus) at the National Aquarium in Baltimore, MD were exposed to social (conspecifics) and non-social (feeding contexts and fish swimming) video segments. Videos were rear-projected onto a large (8 ft X 4 ft) display screen affixed to an underwater window and the dolphins were free to approach or not approach the screen. Sessions were 15-min in duration and were comprised of eighteen novel 30-s videos (6 social, 6 feed, 6 control) presented four times in a pseudo-randomized order. Viewing durations, behaviors, and concurrent acoustic signals detected while viewing were compared between video categories with generalized estimating equations and a variety of non-parametric tests. The results indicate more time spent viewing, more broad burst-pulse signals detected, and less echolocation signals detected during social videos than during feed and control videos. The dolphins demonstrated the ability to discriminate between social versus other video categories, a high motivation to view the social videos, and the use of differential acoustic responses to social videos versus non-social videos. The broad burst-pulse response detected during social videos may be evidence of a social response, but this cannot be determined from this study alone and needs to be replicated in future studies. Notably, while viewing, both dolphins positioned themselves primarily head-on using binocular vision and tracked the on-screen movement with their rostrums which was unexpected based on previous findings. The viewing position adopted by the dolphins may be related to multiple factors including: a preference to view with the temporal area of best vision, to gain depth-perception cues, or to allow for simultaneous processing with both hemispheres. These findings provide support for future use of videos to investigate perception and cognition with delphinids.

**The Sarasota Dolphin Whistle Database: A unique long-term resource for understanding dolphin communication**

Laela Sayigh1, Vincent Janik2, Frants Havmand Jensen1, Michael D. Scott1, Peter Tyack3, Randall Wells6

1Woods Hole Oceanographic Institution/Hampshire College, Woods Hole, Massachusetts, 2University of St Andrews, St Andrews, Fife, United Kingdom, 3Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, 4Dolphin Biology Research Institute, La Jolla, California, 5University of St Andrews, St Andrews, 6Chicago Zoological
Individually distinctive signature whistles of common bottlenose dolphins (*Tursiops truncatus*) are the predominant whistles produced when animals are isolated from conspecifics. Signature whistles are learned early in life and used to recognize and maintain contact with group members. Health assessments of the Sarasota, Florida (USA) dolphin community, during which animals are briefly separated from conspecifics, provide a unique opportunity to record signature whistles of individuals of known age, sex, and matrilineal relationships. Recordings were first made in the mid 1970’s, and then nearly annually since 1984. The Sarasota Dolphin Whistle Database now contains 927 recording sessions of 295 individual dolphins, including 171 individuals recorded more than once (average = 3.1; maximum = 18). The longest time span over which an individual has been recorded is 43 years; 85 individuals have been recorded over a decade or more. Here we describe major features of signature whistles revealed by this unique and expansive dataset, including the variety of whistle contour types (e.g., single vs. multi-loop, variable numbers of loops, deletions, embellishments) and other whistle features (e.g., amplitude modulation, chaos, subharmonics, biphonation, breaks, simultaneous pulsed components, ultrasonic whistle production, disjunct components, steps). As a comparative measure of information content in signature whistles, we calculated Beecher’s Information Statistic based on 20 signature whistles produced by 20 different individuals, and found it to be higher than for any other animal signal studied so far (13.7 bits of information). Thus, signature whistles have an unparalleled capacity to convey information on individual identity. Turning our recording library into a rigorous, systematic database allowed us to expand its reach in facilitating new research projects. One of these focuses on developing machine learning tools to automate classification of signature whistles, a goal that has eluded researchers due to the wide range of features that can define signature whistle contours.

**A previously undescribed baleen whale vocalisation from northwest Madagascar**

**Lorenzo Scala**¹, Chris Pierpoint², Stephanie Barnicoat¹

¹Seiche Ltd., Bradworthy, Devon, United Kingdom, ²Seiche Ltd., Bioscience Group, Devon, United Kingdom

A novel baleen whale call was detected during long-term passive acoustic monitoring using autonomous recorder units (ARUs), at several deep-water locations during a study in northwest Madagascar, between August 2019 and July 2020. The call was extracted using Raven Pro’s Template Detector and was recorded on 48 of 372 deployment days (12.9% DPD). The call consisted of a single stereotyped phrase, containing two tonal units with a mean duration of 11.9 s. Unit 1 began with amplitude modulation (4.7 Hz) which developed into a quasi-constant tone with a peak frequency of 42.7 Hz (7 Hz 90% bandwidth) lasting 5.1 s. There was a short time gap of 1.1 s, followed by Unit 2, which was a flat tone with peak frequency 42.5 Hz (3.1 Hz 90% bandwidth) lasting 5.7 s. The call was repeated in a song-like pattern, typically at intervals of 237 s. The call was not uncommon and was recorded on ARUs located 250 km apart. It was detected at a proportionately higher rate at the southern (0.8% of 15-min files) than in the northern part of the survey area (0.4% files). The temporal occurrence of the call had a bimodal distribution, with peak rates of detection during the austral winter from August to October and in late February to mid-March. The source of the call is not known. However, its characteristics lead us to speculate that it represents a previously undescribed call of a population of blue, Omura’s or Bryde’s whale inhabiting the southwest Indian Ocean. The identification of the
The Salish Sea and North Island Waters are Critical Habitats for Coastal Transient Killer Whales

Taryn Scarff1, Andrew W. Trites2, Jared Towers3
1University of British Columbia, Marine Mammal Research, 2UBC Marine Mammal Research Unit, Vancouver, British Columbia, 3Fisheries and Oceans Canada, West Vancouver

Coastal transient killer whales (Orcinus orca) range from central California to southeastern Alaska in search of marine mammal prey. Photo-identification data of individual whales indicates that their population has increased significantly since the 1970s when marine mammals were protected in Canada and the United States. However, knowledge of how this wide-ranging population uses coastal areas of western North America, and the relative seasonal importance of different portions of their range, are poorly understood. Using sighting reports of transient killer whales from researchers, conservation organizations and whale watching companies from 2016 to 2020, we assessed the distribution and abundance of transient killer whales that feed in the inside waters of Washington State and Vancouver Island, BC (an area that includes the Salish Sea and North Island Waters off northeastern Vancouver Island). We discovered consistent numbers of individuals and matri-groups (a female killer whale, her non-dispersed offspring and individuals known to travel with this group) visiting between years—although we also observed different matri-groups and individuals in different years. Additionally, we found the numbers of coastal transients coming to the inside waters has increased significantly since the 1990s. Seasonally, peaks occurred in June, August and September, which coincides with seasonal increases in transient killer whale prey populations. Overall, we estimate that more than 70% of the entire coastal transient killer whale population travels through and hunts in the inside waters of Vancouver Island each year. This unexpected finding suggests that the Salish Sea and North Island Waters are critical for the survival of coastal transient killer whales, and points to the need to assess the relative importance of other key feeding areas throughout their range from central California to southeastern Alaska.

Indicator for noise impact vulnerability? Grey seals (Halichoerus grypus) have a broad underwater hearing range

Tobias Schaffeld1, Kirstin Anderson Hansen2, Magnus Wahlberg3, Andreas Ruser4, Ursula Siebert5
1Institute for Terrestrial and Aquatic Wildlife Research (ITAW) Buesum, Büsum, Schleswig-Holstein, Germany, 2Marine Biological Research Center, University of Southern Denmark; Fjord&Bælt, Kerteminde, Denmark, 3Marine Biological Research Centre, University of Southern Denmark, Kerteminde, Funen, Denmark, 4Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Büsum, Germany, 5Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Buesum, Schleswig-Holstein, Germany

Grey seals inhabit coastal waters of the North Atlantic Ocean, with an increasing abundance in North and Baltic Seas. Since grey seal distribution overlaps with anthropogenic activities, any potential disturbance has to be considered. Few data are available regarding acoustic sensitivity in grey seals, although the species is known to be vulnerable to human disturbance. Here, we provide a first step towards impact assessment by new information describing the underwater hearing range of two male grey seals in human care. These data were obtained by training the two seals to participate
in behavioural auditory detection tasks. Frequencies between 0.125 and 64 kHz were tested in octave steps. Grey seals proved to have a very broad frequency range with best hearing abilities between 0.5 and 28 kHz. Hearing thresholds could also be determined down to 0.125 kHz and as high as 64 kHz. Our results clearly demonstrate that grey seals are underwater hearing specialists, which may indicate a strong dependence on acoustic cues. The evolution of underwater hearing over such a broad hearing range is very likely driven by ecological advantages, such as localizing sounds from prey and predators, and environmental cues for orientation. The hearing range largely overlaps with anthropogenic noise pollution, which may mask acoustically relevant cues. The potential of acoustic disturbance of grey seals must be considered to ensure future parallel existence of grey seals and anthropogenic activities.

**Identifying Vertical Avoidance Diving Behavior in Cuvier’s Beaked Whales Using Long-duration, Low-resolution Satellite Telemetry Devices**

Josh Hewitt¹, Alan Gelfand¹, Nicola Quick², Brandon Southall¹, **Robert Schick¹**

¹Duke University, Durham, NC, ²Duke University, Marine Lab, Beaufort, NC, ³Southall Environmental Associates, Inc., Aptos, California

Mid-frequency active sonar (MFAS) has been linked to behavioral impacts and mass stranding events in beaked whales. To quantify these responses, controlled exposure experiments (CEEs) have been conducted, in which tagged whales are exposed to MFAS signals at various source levels. Horizontal avoidance responses have been identified from satellite tags attached to some focal animals tracked after exposure. We use data from Cuvier’s beaked whales collected during the Atlantic Behavioral Response study to identify vertical responses, defined as the onset of deep dives to avoid MFAS exposure. Vertical responses may increase a whale’s risk of physiological complications associated with extended deep diving. Diving responses have been observed in previous CEEs, but analyzed without process-driven statistical models. We address two challenges in using models to identify vertical responses from satellite tag data. First, beaked whales typically make ~10 deep dives each day to forage. So, foraging behavior must be separated from response behavior. Second, satellite tags record depth data in low-resolution. A depth range (i.e., 0-20m) is recorded once every 5 minutes, meaning dives are only represented via a handful of coarse depth observations. We define a multi-state continuous-time model for animal movement between discrete depth bins. Out-of-sample validation demonstrates our model can predict if a deep dive following MFAS exposure would likely have been non-deep in the absence of MFAS exposure, providing evidence for vertical responses. The model is successful because it accounts for characteristics that differentiate deep and non-deep dives, such as vertical diving speed and the relative timing of deep dives. The model also provides evidence that avoidance dives are longer than what is predicted before exposure. More broadly, our process-driven model can be adapted to different species, providing a basis for identifying a wide range of disturbances at multiple time scales from relatively low-resolution satellite tag data.

**Using Density Surface Models in a Highly Complex Survey Area (Southeast Alaska) to Estimate Humpback Whale (Megaptera novaeangliae) Abundance and Distribution**

Abigail Schiffmiller¹, Greg Breed², Kimberly Goetz³, Alexandre Zerbini⁴

¹University of Alaska, Fairbanks, ²University of Alaska, Fairbanks, ³NOAA-AFSC-MML, Seattle, WA, ⁴Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA
Estimating population abundances and distributions is key to understanding and managing populations. Complex habitats pose logistical and computational challenges that require more efficient ways to accurately estimate abundance. Line transect surveys conducted for marine mammals traditionally use design-based distance sampling (dbDS) to estimate population abundance and regional density which relies on the assumption that all portions of a study area have equal probability of survey coverage. However, spatially and habitat specific density surface models (DSMs) using line transect data do not rely on this assumption, and provides additional detailed distribution information useful to researchers and managers. We estimated humpback whale (*Megaptera novaeangliae*) distribution and abundance in the inland waters of Southeast Alaska (SEAK), a complex habitat with highly convoluted boundaries, and compared distribution and abundance estimates using dbDS to estimates using DSM with a soap film spatial smoother (sf-DSM). Abundance estimates using dbDS were ~50% higher than those from sf-DSM and it is unclear which abundance estimate was more biased. However, density mapped produced using sf-DSM revealed patterns in distribution that were not discernable using dbDS. Using sf-DSM in complex habitats like SEAK could allow for more frequent but lower cost data collection that would identify critical habitat areas, temporal distribution patterns, and structure of populations.

Bone mineral density and bone microarchitecture in neonate to adult harbour porpoises and harbour seals from the German coast

Britta Schmidt¹, Julian Stürznickel¹, Tim Rolvien³, Ralf Oheim³, Michael Ameling⁵, Ursula Siebert⁶
¹Institute for Terrestrial and Aquatic Wildlife Research, University of Veterinary Hannover, Germany, ²Department of Osteology and Biomechanics, University Medical Centre Hamburg-Eppendorf, Germany, Hamburg, Germany, ³Ham, Germany, ⁴Hamburg, Germany, ⁵University Medical Centre Hamburg-Eppendorf, Hamburg, Germany, ⁶Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Buesum, Schleswig-Holstein, Germany

Harbour porpoises (*Phocoena phocoena*) and harbour seals (*Phoca vitulina*) are the most common marine mammals at the German coast of the North and Baltic Sea. The regulation of bone remodeling homeostasis is influenced by internal and external factors such as hormones, nutrients or environmental factors, potentially leading to an imbalance and a reduction of bone mass. However, little is known about the bone mineral density (BMD) of these species. Therefore, the aim of the present study was to perform a cross-sectional analysis of the BMD in harbour porpoises and harbour seals from the North and Baltic Sea using samples between 2017 and 2021. In total 25 female marine mammals (n̅harbour porpoises=13, n̅harbour seals=14), who were further divided according to the estimated age (based on body length and age determination; neonate (n̅=9), juvenile (n̅=7), and adult (n̅=11)). BMD measurement was performed in all specimens by dual-energy X-ray absorptiometry (DXA). Furthermore, the lumbar vertebrae were examined by high-resolution peripheral quantitative computed tomography (HR-pQCT) to perform three-dimensional quantification of bone microarchitecture at high spatial resolution (voxel size 42 µm). For both species, significantly higher BMD values were detected in older age groups (LM: p-value_harbour seal<0.05, F-value_harbour seal=84.98; p-value_harbour porpoise<0.05, F-value_harbour porpoise=21.09). Inter-species comparison revealed a higher BMD for harbour porpoises in comparison to harbour seals in each of the age groups (LM: p-value<0.05, F-value=14.16). In conclusion, the presented data elucidates the understanding of bone characteristics for harbour porpoises and harbour seals.

567
seals and indicates the need for an in-depth analysis of BMD and bone microarchitecture to establish species-specific reference ranges. The establishment of standards is important to be able to recognize environmental influences on bone. However, larger sample sizes are required to introduce references for the respective age groups of cetacean and seal species.

Macro- and microstructural analysis of the brain of a harbor seal (Phoca vitulina)
Julia Schnermann¹, Markus Axer¹, David Grässel², Vanessa Stammsen², Ursula Siebert³, Katrin Amunts⁴, Frederike Hanke⁵
¹Universität Rostock, Rostock, Deutschland, Germany, ²Institute of Neuroscience and Medicine (INM-1), Research Centre Jülich, Germany, ³Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Buesum, Schleswig-Holstein, Germany, ⁴Institute of Neuroscience and Medicine (INM-1), Research Centre Jülich, Germany, ⁵C. and O. Vogt Institute for Brain Research, University Hospital Düsseldorf, Medical Faculty, Heinrich Heine University Düsseldorf, Düsseldorf, Germany, ⁶University of Rostock, Germany

During evolution, the pinnipeds adapted to an amphibious lifestyle which affected their general blueprint and most likely also their brain. However, hardly anything is known about the pinniped brain. Thus, we set out to systematically describe nerve fiber pathways of a harbor seal (Phoca vitulina) brain using Blockface Imaging and 3D Polarized Light Imaging (3D-PLI). The formalin fixed brain was sectioned at a thickness of 50 µm in the cryostat. During cryo-sectioning, the blockface images were acquired from the surface of the frozen brain tissue. Using the software Atelier 3D, a 3D model of the brain was generated on the basis of the blockface images. The 3D PLI images, on the other hand, were obtained from individual, unstained histological brain sections scanned with a customized polarizing microscope. 3D-PLI is a technique that uses the optical property of birefringence to contrast small fibers and fiber tracts and quantify their local orientation; birefringence is naturally present in neural tissue and is particularly caused by myelinated and geometrically aligned axons. Based on the fiber orientation maps obtained by 3D PLI analysis using Jülich’s supercomputer JURECA, we were able to trace fiber pathways over serial brain sections. 3D-PLI thus allowed the visualization of the nerve fiber architecture of regions of interest within the brain involved in orientation/navigation and visual processing. In conclusion, our study represents the first study to systematically describe the brain of a pinniped macro- as well as microscopically as well as in comparison to the brain of other animals.

Context Matters: Multi-day to Multi-week Sound and Movement Tag Recordings Reveal Individual Variation in Responses of Cuvier’s Beaked Whales to Navy Sonar
Gregory Schorr¹, Stacy DeRuiter¹, Brenda Rone³, David Sweeney⁴, Russel Andrews⁵, Karin Dolan⁶, Erin Falcone⁷, Shannon Coates⁸, Stephanie Watwood⁹

Cuvier’s beaked whales in Southern California appear to respond more strongly to lower-source level helicopter deployed Mid-Frequency Active Sonar (MFAS) than higher source level hull-mounted ship sonar, leading to the hypothesis that exposure context may influence response in addition to received level (RL). To investigate
this hypothesis, we deployed two types of dart-attached, high-resolution archival tags on 10 Cuvier’s beaked whales with the goal of collecting fine-scale data for up to several weeks. Sensors included FastlocGPS, depth, 3-axis accelerometer and magnetometer, and for 6 tags, sound recording at 96 kHz. Tags were deployed ahead of Navy sonar exercises with attachment durations averaging 6.6 days (range=0.1 – 19.7). So far, 94 MFAS exposures have been identified in 65.5 days of tag data, with sources deployed by both helicopters (n=19) and ships (n=75) at distances of 7–100 km from the tagged whale, including both pulsed and continuous MFAS signals. Maximum broadband RLs measured from tag-based sound recordings ranged from 89 – 141 dB re 1µ Pa rms. RLs for tags without on-board sound are being modeled based on the distance to sonar source. Data were analyzed using a hierarchical hidden Markov model assessing both coarse (dive-cycle) and fine-scale (5 min window) responses. Tagged whales demonstrated various behaviors during MFAS, including cessation of foraging and execution of non-foraging deep dives. One whale continued foraging coincident with received levels that caused other whales to stop. One exposure to continuous MFAS (max RL 137 dB) resulted in the longest foraging disruption documented for this population (19 hrs) since tagging began in 2010 (>9,200 hours of dive records). Without the extended sampling capability and the suite of high-resolution sensors in these tags, responses may have been mischaracterized, particularly with respect to their impact on foraging.

Interspecific Associations of Atlantic White Sided Dolphins (Lagenorhynchus acutus) Near Jeffreys Ledge in the Gulf of Maine, USA
Dianna Schulte¹, Jennifer Kennedy¹, Melanie White², Beth Bentley²
¹Blue Ocean Society for Marine Conservation, Portsmouth, New Hampshire, ²Granite State Whale Watch, Rye, NH

Atlantic white sided dolphins (Lagenorhynchus acutus) are known to inhabit the Gulf of Maine and surrounding waters year-round with near-shore sightings most common during the months of June through September. From 2010-2020, observations of Atlantic white sided dolphins (AWSD) were recorded from commercial whale watching vessels by trained observers from May through October of each year. These vessels primarily searched for marine life in or around the area of Jeffreys Ledge, a 54 km long rocky ridge approximately 32 km off the coast of Maine, New Hampshire and Massachusetts, USA. This area is well known for the upwelling currents which attract a variety of prey species as well as cetaceans. Although co-occurrence of species is common in this area, interspecific associations of cetaceans are rarely observed. During this study period, 97 sighting events involving interspecific associations were documented. The most frequent associations observed were between AWSD and fin whales (Balaenoptera physalus) or humpback whales (Megaptera novaeangliae). AWSD were associated with fin whales 51.5% of sightings, humpback whales 45.3% of sightings and other large whales 3% of sightings. Competition for prey (or opportunistic foraging) may explain these associations, as all three species are known to feed on similar resources. However, seven of these events involved whales exhibiting surface resting behavior. Additionally, a shift in frequency of species associations was observed with AWSD associating more often with humpback whales and less often with fin whales in the later years of the study.

The effect of vessel noise on humpback whale (Megaptera novaeangliae) surface behavior on a Southeast Alaskan foraging ground
Josephine Schulze¹, David Lusseau¹, Christine Gabriele¹, Michelle E.H. Fournet³
¹University of Aberdeen/University of St
Breaching is considered to be a multi-functional signal used for communication by humpback whales (Megaptera novaeangliae) as an alternative to underwater vocalizing. A positive relationship between breaching and increased natural noises (e.g. wind) has been documented in migrating humpbacks, but the relationship between breaching and noise from either natural or anthropogenic sources on foraging grounds – where breaching is rare – is not known. The aim of this study is to investigate the effect of ambient noise and vessel presence on humpback whale breaching behavior on foraging grounds in Southeast Alaska. Land-based behavioral data and vessel abundance data were collected over a two-year period (2015 and 2016) during summer months coincident with underwater acoustic data collection. We estimated the association between the number of vessels present, ambient sound levels (dB\text{RMS} 50-1.5 kHz re 1 µPa), and whale abundance, on the number of breaches observed within a 5-minute period using a zero-inflated negative binomial generalized linear model. Whales performed more breaches as the number of vessels increased, but this effect depended on the ambient noise. The number of whales present did not affect breaching events. We suggest that a combination of vessel presence when ambient noise is high may impair foraging efficiency. We now need to assess whether foraging disruption associated with an increased number of vessels needs to be managed to avoid conservation impacts for this population.

**Moms mustache: The tradeoff between individual foraging strategies in an endangered apex predator**

*Jonas F.L. Schwarz*, Friederike Zenth, Eugene DeRango, Stephanie Kalberer, Oliver Krueger

Individual foraging behavior is of great ecological interest, as the diversification of foraging strategies can affect how well populations are able to cope with a changing environment. However, adaptive value, resulting fitness differences, and ecological consequences of different strategies often remain speculative. In this study, we explore three distinct foraging strategies in a population of Galapagos sea lions: benthic, pelagic, and night foraging. We describe the strategy of benthic divers to dig out fish buried in sand by calculating the horizontal body orientation (pitch) of 34 individuals during foraging episodes within dives, identified using a broken stick algorithm and subsequent vertical sinuosity measurement. This foraging behavior results in significant shorter vibrissae of benthic divers due to abrasion, allowing us to visually distinguish benthic divers from the other strategies. Using this information, we were able to amplify our sample size and thus compare the reproductive success of benthic and non-benthic divers, as identified through pictures of their vibrissae, in response to different sea surface temperatures over the last 16 years. Benthic divers demonstrated a stability of pupping rate and offspring’s body condition independent of SST, while the reproductive success of non-benthic divers was higher during low SST but greatly declining with warming oceans. Modelling population growth while incorporating this tradeoff between foraging strategies demonstrates that the potential buffer effect toward rising temperatures is not sufficient to stop the decrease in population size of this endangered pinniped.
Molecular evolution of genes related to antioxidant response in cetaceans

Giovanna Selleghin Veiga1, Mariana Nery2, Érica de Souza2, Lucas Freitas2, Felipe Silva2, Letícia Magpali2

1UNICAMP, Valinhos, São Paulo, Brazil, 2Campinas State University

Cetaceans are a lineage of aquatic mammals completely dependent on the aquatic environment and share many specific adaptations related to living underwater. Here we focused on the ischemia and reperfusion of peripheral tissues, a consequence of vasoconstriction, which are part of the strategies to cope with hypoxia during apnea diving. Reperfusion leads to the production of ROS (reactive oxygen species) by many pathways resulting in oxidative damage. Previous studies showed that cetaceans do not suffer from this issue, mainly due to their antioxidant enzymes. In this study, we aimed to investigate the molecular evolution of known antioxidant enzyme genes such as CAT, GPX3, GSR, PRDX1, PRDX3, SOD1, as well as the production of ROS, by XDH gene. We used the rate of nonsynonymous (dN) to synonymous (dS) substitutions (ω = dN/dS) in the codeML program from the PAML and HyPhy packages to identify adaptive molecular evolution on these genes focusing on cetaceans. We obtained at least 61 mammalian sequences of the main representative mammalian groups, including 16 cetacean species. As some previous studies indicate, our analysis showed that the genes GPX3, GSR, PRDX1, PRDX3 and SOD1 are positively selected in cetaceans, with PRDX1 showing significant differences of ω values between Mysticeti and Odontoceti. We identified 23 and 1 sites evolving under positive selection in PRDX1 and SOD1 respectively, with some sites at positions close to the active site of the protein, suggesting a possible change in functional activity. Comparing these results with the ones found in pinnipeds, the genes under selection were not the same, suggesting aquatic mammals use different antioxidant strategies to cope with oxidative stress.

Looking at Past Data Reveals Risks of Habitat Loss for the Endangered St. Lawrence Estuary Beluga Population

Clément Chion1, Jean-Francois Senecal2, Angélique Dupuch3, Robert Michaud4, Cristiane C. Albuquerque Martins5, Samuel Turgeon6, Emmanuelle Barreau7, Camille Kowalski1, Valeria Vergara8

1Université du Québec en Outaouais (UQO), Gatineau, Quebec, 2ISFORT-UQO, 3Université du Québec en Outaouais, Ripon, Québec, 4Group of Research and Education on Marine Mammals, Tadoussac, Québec, 5Parks Canada, Tadoussac, Quebec, 6Parks Canada, Tadoussac, Québec, 7University of Quebec in Outaouai, Québec, 8Ocean Wise Conservation Association, Vancouver, BC

The St. Lawrence Estuary beluga population (SLEB) is considered endangered under the Canadian Species at risk Act. Despite more than two decades of recovery efforts, this population of less than 1000 individuals continues to decline at a 1% yearly rate. Among the main threats to the SLEB recovery, vessel underwater noise (VUN) is one that can be managed in the short term using appropriate mitigation measures. VUN impact on belugas include behavioral changes, signal masking, and potential damage to their hearing. However, indirect effects of VUN such as habitat abandonment have rarely been documented. In this context, we report on a series of statistical analyses that revealed a negative correlation between the duration of use of the Saguenay Fjord by the SLEB and shipping traffic intensity in this sensitive part of its critical habitat. The Saguenay Fjord is a narrow steep-sided river with a low level of shipping traffic. About 5% of the SLEB population is observed on average in a 30 km-long portion of the Fjord at any given time, the majority of herds being composed of females and calves. We combined 3 independent multiyear datasets of beluga visual
and acoustic observations collected at both extremities of the Saguenay habitat with shipping traffic data from the Automatic Identification System. Statistical analyses consistently revealed that when two or more ship transits occurred in the Fjord within a 24-hour period, the percentage of time that belugas use this habitat the day after decreases by 33.3% to 40.5%. In the context where proposed port-industrial projects could increase mean ship transits in the Saguenay from 1.2 to 3.5 per day, our results emphasize the need to account for the carrying capacity of the SLEB’s critical habitat to prevent habitat loss and comply with its recovery efforts.

Heat Production Related Gene Expression of Blubber of Risso’s Dolphin (Grampus griseus) Uncovered by Transcriptomics

Jayan Senevirathna1, Ryo Yonezawa1, Taiki Saka1, Yoji Igarashi1, Noriko Funasaka2, Kazutoshi Yoshitake1, Shigeharu Kinoshita1, Shuichi Asakawa1
1The University of Tokyo, Tokyo, Japan, 2Mie University, Tsu, Mie, Japan

Dolphins, one group of marine mammals have special aquatic adaptations, i.e., blubber plays main roles in thermoregulation, storing energy, and increasing buoyancy. Lipid composition in blubber varies in different species, however, mostly contains triacylglycerols and wax esters. The blubber of cetaceans can be stratified into several layers. For the detection of potential candidate genes and enrichment pathways, the inner and outer blubber of three Risso’s dolphins were analyzed based on RNA sequencing. As a result, 15720 genes were identified in six samples and 7951 genes were filtered (> 0.5 counts per million) for further analysis. Four clusters of genes were identified according to the k-Means analysis (cluster A – 258 genes, cluster B – 418 genes, cluster C – 934 genes, and cluster D – 390 genes). Genes of cluster B showed enriched pathways such as eukaryotic 43S preinitiation complex, translation regulator activity & nucleic acid binding, formation of cytoplasmic translation initiation complex, and collagen-containing extracellular matrix. A total of 17 and 08 up-regulated differentially expressed genes (DEGs) were detected using Cuffdiff (q < 0.05, log2(fold change) ≥ 1) in inner and outer blubber respectively. The inner blubber contained lipid metabolism-related DEGs (POMGNT1, LRP1, NOX1, PDK4, and MBOAT2) and significant KEGG pathways were revealed (p < 0.05), such as mannose type O-glycan biosynthesis and cholesterol metabolism and gene ontologies (GOs) like regulation of sterol transport (GO:0032371), and pyruvate dehydrogenase (acetyl-transferring) kinase activity (GO:0004740). The outer blubber DEGs were CSRNP1, COX8B, FAM241A, ASPN, LIN1, ACTS, LORF2, and T11L1. These genes didn’t show any significant KEGG pathways, however, one of the significant GOs was included regulation of the transforming growth factor-beta receptor signaling pathway (GO:0017015). This study revealed higher expression of the PDK4 gene in inner blubber which may contain a higher level of brown fat. Also, pyruvate metabolism may enrich due to thermoregulation in the blubber of Risso’s dolphin.

Fisher’s perception of the interaction between South American sea lions and Chinook salmon fishery in southern Chile

Maritza Sepulveda1, Matias Sanguinetti2, Beatriz Cid3, Alicia Guerrero4, Marcelo Duran3, Daniel Gomez-Uchida3
1Centro de Investigación y Gestión de Recursos Naturales (CIGREN), Universidad de Valparaiso, VINA DEL MAR, Chile, 2Universidad de Valparaiso, Valparaiso, Chile, 3Universidad de Concepcion, Concepcion, Chile, 4Universidad de Valparaiso

We studied how the South American sea lion (SASL, Otaria flavescens) interacts with the operation of an artisanal fishery of Chinook
salmon, a non-native species in Chile, using a combination of biological and social approaches, including a valuation by fishers about this interaction. During 2019 austral summer, an observer onboard artisanal fishing boats characterized the attack behavior of SASL to gillnet-captured Chinook salmon during 33 hauls and analyzed which factors may affect the intensity of attacks. A total of 23 interviews with fishers were also conducted to describe how fishers perceived these interactions. Interactions were recorded in 35% of the fishing events and varied depending on both operational factors, such as the number of vessels, as well as environmental factors, such as moon luminosity. A total of 87% of the interviewed fishers consider the conflict with the SASL as very important. The results show that there is a negative perception regarding the presence of SASL, despite the fact that the interactions do not represent a substantive economic issue for the fishers. While older fishers with less formal education have a purely instrumental focus, younger leader fishers with a more sustainable and conservationist view of fishing offer an opportunity for an improved local understanding of the coevolution of the relationship between salmon, SASLs, and humans.

**Beneath the surface: Diving behavior of false killer whales from two populations across diel and lunar cycles in Hawaiian waters**

Jacquelyn Shaff¹, Michaela Kratofil², Robin Baird³

¹Cascadia Research Collective, University of Washington, ²Cascadia Research Collective, Oregon State University, ³Cascadia Research Collective, Olympia, WA

Long-term datasets of two island-associated false killer whale populations in Hawai‘i provide unique insights into the variability of this top predator’s foraging ecology and habitat use. Observational studies indicate that false killer whales regularly forage during the day on large epipelagic and reef-associated game fish, but stomach contents from stranded animals from the endangered main Hawaiian Islands (MHI) population suggest they also feed on deeper mesopelagic cephalopods. We used depth-transmitting satellite tag data from five individuals (71 days) from the MHI population and three individuals (31 days) from the Northwestern Hawaiian Islands (NWHI) population to investigate the effects of lunar and solar cycles on behavior. Individuals from both populations were typically in waters 600-3,000m deep and spent between 82-96% of their time in the top 30m of the water column. Mean shallow dives (<182m from k-means cluster analysis) were 72m (SD=21) deep and 3.7min (SD=0.6) long. Mean deep dives (>182m) were 430m (SD=58.8) and 7.8min (SD=1.0), with the deepest and longest dives recorded at 1,272m and 19.0min. On average, dives deeper than 500m occurred twice per 24-hr period, with seven individuals diving to depths over 800m. The occurrence of deep dives was highest during dawn and day compared to dusk and night. On average, dives from NWHI individuals were 6km further offshore, and shallow dives were 24m deeper compared to MHI individuals. Dives varied with lunar phase, showing deeper nighttime deep dives increasing with lunar illumination. Deep dive depth increased with bathymetric depths up to about 1,300m where the deepest dives occurred, suggesting they sometimes forage at or near the sea floor. Variations in diving patterns may align with shifts in prey preference from epipelagic to mesopelagic species across solar and lunar light cycles. Combining observational work with satellite tagging provides a greater understanding of foraging across time scales, habitats, and populations.

**About the protected natural area in the Kazakhstani part of the Caspian Sea for the conservation of the Caspian seal (Pusa caspica)**
In 2021, the Species Survival Commission and the World Commission on Protected Areas of the IUCN informed that three key habitats of the Caspian seal (*Pusa caspica*) were awarded the international status — Important Marine Mammal Area (IMMA). Studies conducted during 2015-2021 in the Kazakhstani part of the Caspian Sea revealed the distribution, the number of the population, size structure of seal aggregations in haulouts, estimated mortality, and the impact of various natural and anthropogenic factors on seals during periods of occurrence. As a result of a comprehensive analysis of literary and proprietary data, it is proposed to organize a state nature reserve. According to the legislation of Kazakhstan, this type of specially protected natural area is intended for the conservation and restoration of lost habitats and the number of species. It is crucial to consider the variability of key habitats because of the phenomenon of periodic changes in the Caspian Sea level, migration of the species by sea, the increased economic impact on the sea's ecosystem.

It is recommended to organize a mosaic-type reserve consisting of various spatially separated areas: haulouts and the water area around along the northeast coast of the sea, the Tyuleniy Archipelago, the islands in the Kendirli Bay. It is necessary to approve an ecological corridor on the migration routes and foraging places. The adoption of special Rules of economic activity will ensure the protection of IMMA in a flexible model. Rehabilitation centers for sick, injured seals should function as part of the reserve. Based on interstate agreements of the Caspian littoral states, it is possible to subsequently create a cross-border reserve for the conservation of the Caspian seal population. The research was carried out with financial support from Kazakhstan's Ministry of Ecology, Geology, and Natural Resources (Grant BR10264205) and Tengizchevroil LLP.

Assessing characteristics of small-scale fisheries to inform cetacean conservation in Bangladesh

**Shanta Shamsunnahar**¹, Ashik Jahan Galib², Elisabeth Fahrni Mansur², Mohammad Shamsuddoha³, Lisa T. Ballance³

¹Oregon State University, Newport, OR, Bangladesh, ²Wildlife Conservation Society, Bangladesh, ³Oregon State University, Newport, Oregon

Fisheries bycatch has long been the greatest threat to many marine mammals. Interactions between small-scale fisheries and cetaceans are increasingly recognized as problematic at best, and threatening extinction at worst. We conducted vessel-based surveys in the coastal waters of Bangladesh to assess the impacts of small-scale fisheries on cetaceans and other marine megafauna including elasmobranchs and marine turtles. Two surveys were conducted in December-January of 2017/18 (28 days) and 2018/19 (23 days) using line transect methods to estimate distribution and relative abundance of cetaceans and fishing gear, and sample target and non-target catches (57 net sets). We also interviewed 88 fishermen. We recorded 1,662 pieces of fishing gear in depths of 4-125 m. We categorized these in 10 types: drifting large, medium, small mesh and anchored gill nets; estuarine and marine set bag nets; longshore nets; baited and unbaited long lines; and stern trawlers. Marine set bag nets (mesh 0.5-10 cm), medium mesh (mesh 8-13 cm), and large mesh (mesh 16-19 cm) gillnets were the most abundant gear types representing 32%, 18% and 8% of all fishing gears, respectively. No cetaceans were...
found in our catch sample. However, interviews resulted in reports of 12 entangled cetaceans from four species: Irrawaddy (*Orcaella brevirostris*), finless porpoise (*Neophocaena phocaenoides*), Indo-Pacific humpback (*Sousa chinensis*) and Indo-Pacific bottlenose (*Tursiops aduncus*) dolphins with all except one in drifting gill nets, and all globally threatened or near threatened. Three were reported dead and discarded; the fate of the other nine was unknown. Our data suggest that medium mesh gillnets accounted for most (n=7) cetacean entanglements. Coastal small-scale fisheries are vital for substantial income and food security in Bangladesh. Therefore, conservation efforts to reduce cetacean bycatch must be synergistic with effort to sustain productive fisheries. Our data provide a baseline for further research to achieve this goal.


Nathan Shapiro, California State University Channel Islands, Canyon Country, CA

Humpback whales (*Megaptera novaeangliae*) feed on krill and small fish while located in and around the Alaskan Gulf during the Spring months. Summer is peak feeding time - during this time they are distributed across the temperate coastal waters of the North Pacific. In the winter months, the whales travel to Hawai‘i. For the duration of winter, they utilize fat reserves while nursing and weaning their calves. A whale’s body condition is very important when assessing the overall health of the population and can be adversely impacted by changes in food supply. Food supply can be impacted by several factors such as changing ocean currents, warming water and the increase in sea surface temperature. This decreased change in the total food supply is preventing migrating whales from storing up sufficient calories for the long journey and sufficient supplies to last for the summer. To better determine how caloric resources are being stored among the adult and maternal whales, our team worked to create a measurement protocol to determine health conditions of migrating and nursing whales. This will provide details on a body condition index (BCI) and ultimately help to answer the question of how the impacts of inadequate food supplies caused by climate anomalies are impacting the size of the distinct population segment of Hawaii’s Humpback whales. The fundamental goal of this long term study is to assess the changes in the body condition health of the Hawaiian Distinct Population Segment (DPS). Within the work presented below, this study seeks to look at the body conditions of the gender-based cohorts over a two-year time scale. The findings from this study indicate that there was not a significant temporal change in body conditions of the gender-based cohorts from the 2019 to 2020 seasons.

Convolutional Neural Network Based Click Detection Improves Accuracy and Retains Attenuated Clicks in Vocal Exchanges

Pratyusha Sharma¹, Shane Gero², Michael Bronstein², Gasper Begus², Shafi Goldwasser², David Gruber², Dan Tchernov¹, Robert Wood¹, Jacob Andreas³, Daniela Rus³, Antonio Torralba³

¹Massachusetts Institute of Technology, Cambridge, Massachusetts, ²Aarhus University, Aarhus, Aarhus C, Denmark, ³Haifa, Israel

Technological advances have provided tools needed to collect ever-increasing amounts of bioacoustic data; however, the techniques needed to analyze large datasets have not scaled at the same rate. We developed a convolutional neural network (CNN) based model for click detection which would make possible processing and precisely annotating orders of magnitude more data. Sperm whales (*Physeter macrocephalus*) vocalize to both communicate and echolocate using impulsive broadband clicks. The automated
detection of clicks, particularly when analyzing coda exchanges in which precise inter-click intervals are used to define coda types, is critical to advance our understanding. This network is trained using manually annotated coda clicks from The Dominica Sperm Whale Project animal-worn tag dataset (42 tags 2014-2018; 3948 codas; 22,302 clicks). The detector takes as input a context window (2sec) of the audio file and regresses to the location of the peak if present in a smaller decision window (0.01sec). The context window ensures that the decision is conditioned on a wider context of the signal when deciding whether and where a click may be present in the decision window. To train a robust detector, hard negatives were generated by jittering the signal within the decision window.

Previous approaches trained to detect clicks used an amplitude threshold to filter clicks for training, as a result, the performance of the detector dropped to 7% on attenuated clicks from 100% on loud clicks. It further did not detect the location of the peaks. Our model detects the precise location of the peaks for 93.6% of the clicks in a held-out test set and could recover some of the attenuated clicks which were missed during manual annotation. Importantly, analyzing vocal exchanges necessitates detecting attenuated clicks by the distant speaker(s) to recover complete conversations in both animal-worn and passive acoustic systems.

Rescue, Release, and Satellite Tracking of Two Stranded Minke Whales (Balaenoptera acutorostrata) on Cape Cod, MA, US
Sarah Sharp1, Olivia Guerra2, Jane M. Hoppe3, Nicole Hunter4, Kira Kasper5, Michael J Moore6, Misty Niemeyer7, Kathryn Rose8, Kristen Patchett9, Kristen Volker4, Brian Sharp2
1IFAW, Yarmouth Port, MA, 2International Fund for Animal Welfare, Yarmouthport, Massachusetts, 3IFAW Marine Mammal Rescue and Research, Yarmouth Port, Massachusetts, 4IFAW, 5IFAW, Yarmouthport, Massachusetts, 6Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, 7International Fund for Animal Welfare, Yarmouthport, Massachusetts, 8International Fund for Animal Welfare

Live stranded large whales pose significant logistical and welfare challenges for responders. Additionally, they are often ill at the time of stranding and/or their health rapidly declines due to respiratory and circulatory collapse from recumbency on land. However, there are rare occasions when favorable environmental conditions may facilitate a rescue and the stranded whale presents in good apparent health. Between 2017 and 2020, eight live minke whales (Balaenoptera acutorostrata) stranded on Cape Cod, MA, USA. Three were euthanized, three died, and rescue was attempted in two cases. Five live whales received a physical examination and point of care bloodwork in the field. The most significant abnormality on physical examination of the refloated whales was bilateral slow, pendulous horizontal nystagmus, the resolution of which was documented after refloation in one whale. Both refloated whales also had markedly elevated plasma creatinine levels. A temporary single pin satellite tag was attached to each animal’s dorsal fin and they were refloated on the incoming tides using either a whale pontoon system or straps and towed into deeper water by a vessel. In one case, the tag transmitted for 83 days and the whale traveled a minimum of 11,140 km along previously hypothesized minke whale migratory routes. To our knowledge, this is the first documented survival of a satellite tagged, refloated, and released stranded large whale and the first non-acoustic documentation of a minke whale migratory route to its southern habitat in the Western North Atlantic. In the second case, tag transmissions 16 hours post-release indicated the whale was in a remote marsh location 25 km from the release site. The whale was found dead and was towed and necropsied the following day. These cases validate the need for a thorough health assessment and telemetry attachment on any stranded whale prior to...
Play is volitional, pleasurable activity that benefits individual well-being via enhanced motor skills, cognition and behavioral plasticity. Among dolphins, the creation of bubble rings (tori) and their ensuing manipulation (fusion, flipping, leap-frogging, swim-through) is well-documented and deemed play behavior. Ring creation provides insight into dolphin mood, intent and technical intelligence. Creating air-infused tori requires practice, body posturing and the injection of air from mouth or blowhole or the use of flippers and flukes. Among mysticetes, humpback whales are the most bubbliferous, deploying curtains and clouds during barrier-feeding and male jousting. Humpbacks also use bubble nets to trap prey by releasing a curtain of air while swimming in a closing spiral. In contrast, the expulsion of bubble rings (a singular, poloidally spinning, air-infused vortex) is largely unknown among mysticetes. Here we analyze video footage and conduct interviews with naturalists/citizen scientists concerning ring production by four different humpbacks. All events were initiated with a “curious” encounter, whereby a humpback approached a stationary whale watch vessel, but then initiated ring production. The blowhole was deemed the primary site of ring production (often from a single nostril). Torus diameter ranged from an estimated .2 to 3 meters with a max air volume of 200 liters. Competing theories of foraging and aggression were discounted in favor of self-created play objects with secondary interactions including swim through, tail drag and Bellagio (a conspicuous subsurface exhalation, blowing seawater aloft). Bubble rings occur at the end of a structural and volitional continuum, ranging from chaotic plumes, often expelled from both nostrils (startle or jousting) to more spatially and temporally compact bursts (curiosity) to rings (playful). It is not understood why some whales go beyond typical curious encounters and innovate with bubble ring production. Animal-focused communication (using their lexicon/gestures) suggests that experimental ring presentations - in the whale's habitat - could be revealing. When receiving a signal of unknown meaning, especially a non-threatening one, communication theory, and the tenants of animal play, oblige taking turns, mirroring and innovation.
abstracts was compiled, representing odontocete research from the 20th and 21st century. The corpus was evaluated using Latent Dirichlet Allocation (LDA) to identify research topics, interpreted using a set of associated keywords. The analysis identified 30 topics of which 17 represented research relevant to population ecology or conservation. Temporal trends in the annual production of articles per topic were identified using Generalised Additive Models. The representation of each odontocete genus within the whole corpus and each topic was considered. Topics interpreted as Habitat Modelling, Conservation Management, Population Dynamics and Statistical Modelling showed the greatest increase within the last 30 years, indicating increased research focus on conservation. However, Fisheries Interaction and Organochlorine Contamination decreased since 1995 and 2005, respectively. Words associated with policy and mitigation were not well represented across all topics suggesting limited research in this area.

The genus *Tursiops* was most represented, included within 27% of all abstracts. Genera with least representation included *Feresa*, *Lissodelphis*, *Indopacetus* and *Tasmacetus*. Topics interpreted as Vessel Response, Reproduction, Noise Impact and Social Ecology had notably limited genus representation. This research suggests conservation action is increasing but research gaps exist for certain genus groups and for demonstrating policy change and its impact. Renewed focus on fisheries interaction and mitigation of its impact is also required, considering its prevalence and effect on mortality.

*Keeping an ear in the water: Comparing C-POD and SoundTrap click detectors for use in long-term acoustic monitoring of harbour porpoise (Phocoena phocoena)*

Hannah Shaw¹, Denise Risch², Suzanne Beck³, Cathy Gibson¹, Ewan Edwards³

Passive acoustic monitoring is commonly used for long-term assessments of cetacean populations. The characteristic narrow-band, high-frequency (NBHF) echolocation clicks produced by harbour porpoises allow for their continued and successful monitoring with automated click detectors. One of the first and most widely used devices to detect and classify these clicks are C-PODs (Chelonia Ltd., UK). In more recent years, new broadband recorders with on-board, high-frequency click detectors, such as the SoundTrap (Ocean Instruments, NZ) have been used to monitor NBHF clicks alongside lower frequency signals from other species, whilst simultaneously conducting ambient noise assessments. To preserve memory and extend monitoring periods, C-PODs record summary data for detected NBHF clicks, while the SoundTrap click detector extracts short snippets of broadband sound around click detections. In this study, C-PODs and SoundTraps were co-deployed as part of a long-term monitoring programme across western Scotland and Northern Ireland, including within two marine protected areas for harbour porpoise. We collected one year of overlapping data from ten different deployment sites to investigate whether the number of porpoise positive minutes (PPM), hours (PPH) and days (PPD) correlate between the two approaches and how results vary spatio-temporally. C-POD data were analysed using the ‘KERNO’ classifier and ‘HiMod’ and ‘HiModLo’ filters for NBHF click trains, while SoundTrap click detections were processed using a customised click classifier in PAMGUARD. Initial results showed that PPDs appear to be highly correlated between detectors, with the...
other measures still to be compared. Further, we will investigate whether detection results are influenced by fluctuating environmental and anthropogenic noise conditions present within sites. This study will highlight potential differences in performance between the two different NBHF click detection approaches and results will be discussed in the context of different research questions and monitoring goals, such as porpoise monitoring within marine protected areas.

**Short-Finned Pilot Whales (Globicephala macrorhynchus) Foraging Along the Atlantic Continental Shelf Break Employ Multiple Prey Capture Strategies, Including Benthic Feeding and Mid-Water Sprints**

Jeanne Shearer1, Frants Havmand Jensen2, Nicola Quick1, Ari Friedlaender1, Brandon Southall1, Doug Nowacek3, Matthew Bowers1, Heather Foley3, Zachary Swaim3, Danielle Waples4, Andy Read5

1Duke University, Beaufort, NC, 2Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, 3Duke University, Marine Lab, Beaufort, NC, 4University of California Santa Cruz, Santa Cruz, California, 5Southall Environmental Associates, Inc., Apts, California, 6Duke University, Beaufort, North Carolina, 7Southall Environmental Associates, Apts, CA, 8NOAA Fisheries NEFSC Integrated Statistics, Woods Hole, MA, 9Duke University Marine Laboratory, Beaufort, NC

Most previous studies of the foraging ecology of short-finned pilot whales have focused on island-associated populations in oligotrophic, pelagic ecosystems. Here we investigate foraging behavior of this species in a highly productive continental shelf-break system, to understand how behavioral strategies vary with habitat. Between 2008 and 2016 we deployed 31 DTAGs on short-finned pilot whales near Cape Hatteras, NC, USA. These whales made 375 dives (>20 meters) reaching depths of 1077 meters and durations of up to 23 minutes. We used a supervised click detector to identify foraging buzzes. On average, whales made 12 prey buzzes per foraging dive (maximum 54) with a mean of 0.8 buzzes/minute (maximum 3.6 per minute). Whales foraged in all dive phases, but two-thirds of buzzes occurred in the bottom phase (>85% of maximum depth). Half of all buzzes occurred between 320 and 720 meters. We observed no diel variation in dive depth, dive pattern, or number of buzzes. We detected energetically costly foraging behaviors (sprints), with bursts of speed over 3 m/s recorded in 160 dives and a maximum velocity of 6.9 m/s. Whales also routinely engaged in benthic foraging; we detected seafloor echoes on 75 dives (20%) from 22 individuals. Animals approached within 20 meters of the bottom in 65 of these dives, at depths of 275 to 1080 meters. Pilot whales off Cape Hatteras exhibited high-speed sprints similar to those reported from the Canary Islands, but they also engaged in benthic foraging, showed higher buzz rates, and showed no diel patterns in sprint frequency, buzz frequency, or dive pattern. Our results demonstrate that short-finned pilot whales exhibit significant plasticity in foraging behavior which likely reflect local ecological conditions. The ability of this species to adapt foraging strategies to local habitat features contributes to their ecological success in a variety of environments worldwide.

**Beluga Harvest in Cook Inlet, Alaska, 1987-2022**

Kim Shelden1, Barbara Mahoney2, Greg O’Corry-Crowe3, Kathryn Frost1, Ronald Stanek1

1Alaska Fisheries Science Center, Seattle, Washington, 2Alaska Regional Office, NMFS, NOAA, Anchorage, AK, 3Florida Atlantic University, 4Alaska Dept. Fish and Game (retired), KAILUA KONA, HI

To fully comprehend the role and importance of Alaska Native harvest of belugas, Delphinapterus leucas, in Cook Inlet (CIB) in the decade prior to
the listing of the stock as Depleted under the U.S. Marine Mammal Protection Act (MMPA), and its subsequent listing under the U.S. Endangered Species Act (ESA) in 2008, we need to understand the relationship between the harvest and the decline in whale abundance. Our reanalysis of reported landed and struck and lost CIBs during the 1980s and 1990s indicates that annual harvests were substantially larger than totals presented in the Cook Inlet Beluga Whale Recovery Plan (2016), and occurred both before and during the decline in the late 1990s. The Plan suggested the decline from 1,300 to 650 whales in 1979-1994 could be explained assuming similar harvest effort to the late 1990s. The rate of decline, ~6% per year for 1979-1991, compared to 1991-1994 with a decline of ~16% per year (from 1,000 to 650 whales) suggests increased harvest effort after the 1980s. Beluga behavior such as aggregating in specific coastal habitats during summer for calving and foraging was a contributing factor. Newspaper articles featuring subsistence hunters and research teams in 1994 likely increased hunting interest as well. Determining the magnitude of the beluga harvest during the period of population decline was difficult because it was not possible to interview all hunters or hunting households to obtain an accurate account of the whales landed or struck and lost. Although MMPA harvest reporting regulations enacted in 1994 improved monitoring and data collection, hunter participation is crucial to obtaining accurate take numbers. Following a harvest moratorium in 1999, a limited harvest (1-2 whales) occurred until 2005. Adoption of a Harvest Table to calculate strike limits when the 5-year average abundance is >350 whales resulted in no harvest from 2005 to 2022.

Marine mammals are facing increased noise in the ocean from anthropogenic activities, including shipping, sonar, and ocean drilling. Acoustic disturbances can have a large impact on these animals, which use sound and hearing for essential tasks such as foraging, communication, and avoiding predators. Previous studies investigated the impacts of acoustic disturbances by exposing animals to acoustic stimuli from a distance, which led to unknown received levels and a limited possibility of repeated exposures. This study used a new animal-borne biologger that combined a speaker that played an experimental acoustic disturbance with a motion sensor to record three-dimensional movement. The aim was to determine whether northern elephant seals (Mirounga angustirostris), a model for deep-diving marine mammals, exhibit a stereotypical behavioral response when exposed to a killer whale whistle, an acoustic stressor. We instrumented and translocated elephant seals from Año Nuevo State Park to Monterey, CA, and programmed the tag to expose the seals to experimental acoustic disturbances at specific timepoints while at sea. When exposed to the stressor during the ascent phase of a deep dive, changes in dive behavior and acceleration were observed from the seals. They performed a dive inversion in which they changed directions and resumed their descent, which resulted in longer dives. The elephant seals also briefly increased their flipper stroke rate following the acoustic disturbance, then

Behavioral response to an experimental acoustic disturbance in northern elephant seals

Daphne Shen1, Holger Klinck2, Allyson Hindle3, Cassondra Williams4, Markus Horning5, Paul Ponganis6, Daniel Costa7, Birgitte McDonald8

1Moss Landing Marine Laboratories, Marina, CA, 2Cornell University, Ithaca, New York, 3University of Nevada Las Vegas, Las Vegas, NV, 4National Marine Mammal Foundation, San Diego, CA, 5Wildlife Technology Frontiers, Seward, Alaska, 6Scripps Institution of Oceanography, La Jolla, CA, 7Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, 8Moss Landing Marine Laboratories, Moss Landing, CA
glided to depth before resuming their ascent. These short-term changes give insight into immediate fine-scale behavioral modifications, but the repeated exposures allow us to learn more about how the elephant seals respond over time. Knowledge of how one deep-diving marine mammal reacts to an acoustic stressor can lead to better understanding of how more at-risk species may be affected by disturbances, which may lead to better informed regulations of sounds in the ocean.

**Intra- and inter-annual variation in Grey seal maternal-offspring energy transfer captured using a novel UAS 3-dimensional photogrammetry method**

Michelle Shero¹, Julian Dale², Alexander Seymour¹, Mike Hammill³, Arnaud Mosnier⁵, Samuel Mongrain⁶, David Johnston⁷

¹Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, ²Duke University Marine Lab, ³Duke University, Beaufort, North Carolina, ⁴Department of Fisheries & Oceans Canada, Rimouski, Quebec, ⁵Fisheries and Oceans Canada, Mont-Joli, ⁶Canadian Department of Fisheries and Oceans, Longueuil, Quebec, ⁷Division of Marine Science and Conservation, Nicholas School of the Environment, Duke University Marine Laboratory, Beaufort, North Carolina

We present the application of unoccupied aircraft systems (UAS; drones) for fine-scale three-dimensional photogrammetry of free-ranging pinnipeds. UAS imagery of grey seals (Halichoerus grypus) was collected at Saddle Island, Nova Scotia during the breeding season in 2019 and 2020. A multirotor UAS was piloted in 360-degree orbits around relatively dense animal aggregations (1-46 animals) and georeferenced images were used for construction of a 3-D point cloud, orthomosaic, and Digital Surface Model for animal volumetric measurements. The 3-D photogrammetric method was validated by hand-measuring (morphometrics, blubber depth) and weighing a subset of individuals directly after UAS survey, and precisely predicted ‘true’ body mass (mean absolute error, adult female: 3.8 kg, 2.1% body mass; pup: 4.1 kg, 9.8%), yet exhibited a weaker relationship with blubber stores. The method was applied to 673 free-ranging animals to characterize volume and mass dynamics across lactation and breeding for a much larger sample size than would be possible by capturing and weighing animals on the ground. Adult females lost, and conversely pups gained, body volume more rapidly in 2019 (females: –4.86±0.85; pups: +2.88±0.34 L day⁻¹) than in 2020 (females: –1.93±0.50; pups: +0.90±0.16 L day⁻¹; both ages P<0.001) and the effect was greater in pups than adults, resulting in a higher volume/estimated mass transfer efficiency in 2019. This could reflect differences in late-gestation foraging conditions or different cohorts returning to the study site; however, there was a remarkable difference in ice conditions between years (2019: 90-100%, 2020: 10-30% ice cover) forcing higher density aggregates of animals at the breeding colonies in 2020. There are likely to be interactive effects between grey seal populations expanding towards carrying capacity and climate regime shifts. Both population expansion and long-term declining trends in ice extent would increase breeding colony densities and may alter how maternal-offspring energy conflicts are balanced.

**Using North Atlantic Right Whale Family Lineages as a Conservation Tool**

Kara Shervanick, ERT, Inc at NMFS Southeast Regional Office

While it is common for researchers to use names and numbers to identify individual marine mammals, there are few populations that are studied for long enough or intensely enough to develop family lineages. Notable examples include Sarasota Bay’s common bottlenose dolphins and two critically endangered species, Southern Resident killer whales and Hawaiian
Synchrony of Haul-out in Wild Spotted Seals
Mio Shibuya¹, Mari Kobayashi²
¹Institute of Low Temperature Science Hokkaido University, Tokyo, Japan, ²Dept of Ocean and Fishies Sciences, Abashiri, Hokkaido

The spotted seals, *Phoca largha*, there is no scientific knowledge of sociality other than breeding activity. However, while on land, they are occasionally observed to be alert to their surroundings and exclusive towards other individuals. In addition to the above behaviors, a variety of other behaviors have been observed, such as the nose-to-nose contact behavior, rolling and synchronized swimming. However, the significance of the observed behaviors and the characteristics of seals that perform the social behaviors have not been clarified. Therefore, in the present study, we first focused on whether the individuals that showed social behavior were specific to each other, and aimed to verify the relationships between them from individual identification. For the analysis, we used photographs and videos taken between August 2016 and March 2017, recording behaviors during swimming, when social behaviors occur more frequently and have a larger repertoire. We also identified individuals for which social behavior was observed. In the present study, we defined a group as those seals that had performed social behavior and were classified according to the type of social behavior, and the number of individuals, growth stage and sex of each group were investigated. The individual identification of the haul-out seals was carried out and a mathematical model was used to examine how often the groups identified while swimming hauled-out in the same site at the same time (synchronous haul-out behavior). In this survey, 41 groups are confirmed by individual identification. The behavior of nose-to-nose contact is frequently observed between mothers and their pups, suggesting that it is an affinity behavior. The groups in which this behavior is frequently observed tended to haul-out relatively close together in the same site at the same time. Furthermore, since these groups are composed of immature individuals, there is highly likely some social relationship between them.

Population genomics of bottlenose dolphins (*Tursiops truncatus*) in the northwest Atlantic
Nikki Shintaku¹, Samantha Townsend², Nicola Quick³, Andy Read⁴, Jason Somarelli⁵, Heather Foley⁶, Danielle Waples⁷, Zachary Swaim⁷, Kim

monk seals. While enough is known about the endangered North Atlantic right whales (NARW), their family lineages are not utilized to the same extent as the other species. Family lineages are best known for promoting conservation messaging and highlighting threats to a species. While family lineages are powerful outreach tools, they can also be used to measure success of intervention programs or investigate human interaction rates. For example, estimates are that a minimum of 30 percent of monk seals are alive today due to human intervention. Additionally, analyses of common bottlenose dolphins in Sarasota Bay suggested that dolphins learn unhealthy feeding behavior from one another, they can teach it to their calves and grand-calves, and found that multiple animals in a family died as a result. Other species use family lineages as a conservation tool. For NAWRs, family lineages are used on an ad hoc basis to celebrate births or highlight threats through mourning a well-known whale; however, they are not regularly used for proactive conservation messaging, to show disentanglement program success, or investigate the risk of human impacts. The North Atlantic Right Whale Consortium Catalog can provide insight into NARW family lineages and the conservation benefits they can provide. For a species whose population has declined over 20 percent in the last decade, we need to be using every tool in the tool box and we need to make family lineages one of those tools.
Bottlenose dolphins (*Tursiops truncatus*) are widely accepted as belonging to one of two ecotypes: offshore or inshore. These ecotypes exhibit remarkable differences in ecology, morphology, and genetic diversity. However, regional patterns of genetic differentiation and stock delineation remain poorly defined for both ecotypes. To improve our understanding of the population structures among these groups we investigated genome-wide genetic variation from 96 biopsy samples collected from bottlenose dolphins in inshore and offshore waters of the northwest Atlantic from North Carolina to Florida using restriction site associated DNA sequencing to infer population structure. Analysis of 14,783 single nucleotide polymorphisms revealed at least three genetically differentiated populations. Our results suggest an inshore population along North Carolina’s Outer Banks (n=32), an offshore population off the continental shelf break from North Carolina to Jacksonville, Florida (n=38), and a shelf population off Jacksonville, Florida (n=26). Bayesian clustering showed significant admixture between the North Carolina and Jacksonville populations, providing potential evidence of historical or current gene flow. Most of the offshore samples were collected off Cape Hatteras, but this population also includes four individuals sampled beyond the continental shelf break off Jacksonville, FL, in close spatial proximity to shelf animals. This suggests a sharp distinction between shelf and offshore individuals structured by the shelf break itself. Such habitat heterogeneity is likely a driver in diversifying populations through influences on social behavior and foraging strategies. Our analyses provide fine-scale genetic resolution of bottlenose dolphin population differentiation in the Western North Atlantic. These results help inform conservation management and advance our understanding of mechanisms that may drive the evolution of population genetic structure.

Adipose-derived hormones vary across natural fasts and show strong associations with immune markers and metabolites in adult male northern elephant seals (*Mirounga angustirostris*)

Garrett Shipway\(^1\), Caroline Rzucidlo\(^2\), Daniel Costa\(^3\), Jane Khudyakov\(^4\), Daniel Crocker\(^5\)

\(^1\)Sonoma State University, Santa Rosa, CA, \(^2\)Woods Hole Oceanographic Institution, Massachusetts Institute of Technology, Woods Hole, MA, \(^3\)Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, \(^4\)Department of Biological Sciences, University of the Pacific, Stockton, California, \(^5\)Sonoma State University, Rohnert Park, CA

Adipose tissue serves a vital role in both thermoregulation and energy storage in marine mammals. Blubber may also be necessary for the endocrine system, producing adipokine hormones. While adipokines are the subject of intensive study in model biomedical systems, their functional roles in wildlife are poorly studied. Capital breeding phocids undergo large changes in adipose reserves during natural fasts creating an ideal system to examine adipokine function. We measured serum concentrations of four adipokines, leptin, adiponectin, resistin and visfatin, in 130 adult male northern elephant seals across their breeding and molting fasts and examined associations with mass, body condition, cortisol, immune markers and metabolites. Leptin concentrations were highest...
at the beginning of fasts and showed complex associations with adaptive and innate immune markers. Adiponectin varied with body composition decreased across the fast. It showed a strong negative association with plasma glucose, consistent with its insulin-sensitizing role. Resistin concentrations were highest during breeding but did not vary with fasting or body condition. Resistin showed a strong positive association with inflammatory cytokines, suggesting production by activated macrophages and an important role in regulating immune function. Visfatin concentrations were highest during breeding, increased with fasting, and were strongly associated with cortisol levels and inflammatory cytokines. Blubber samples from 28 males are being analyzed for gene expression to better understand the regulation of production and release of these adipokines during fasting. Together these findings suggest essential regulatory roles for adipose-derived hormones that link body condition changes to physiological function during breeding and molting fasts.

Assessing Temporal Changes In Southern Right Whale Foraging Ecology And Female Reproductive Cycles
Loraine Shuttleworth7, Els Vermeulen1, Alejandro Fernandez Ajo2, Emma Carroll3, Kathleen Hunt4, Luciano Valenzuela5, Andre Ganswindt6, Simon Mduduzi Seakamela7

1Mammal Research Institute Whale Unit, University of Pretoria, South Africa, Hermanus, Western Cape, South Africa, 2Oregon State University, Marine Mammal Institute, GEMM Lab, Instituto de Conservacion de Ballenas de Argentina, Oregon State University, Flagstaff, AZ, 3University of Auckland, Auckland, New Zealand, 4Smithsonian-Mason School of Conservation, Manassas, Virginia, 5Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Quequén, Buenos Aires Province, Argentina, 6Department of Forestry, Fisheries and the Environment, Cape Town, South Africa

Since their international protection in 1935, certain southern right whale (Eubalaena australis; SRWs) populations have been recovering steadily, but they are still far below historical population numbers and are subject to increasing anthropogenic pressures. As capital breeders, the species migrates from offshore summer feeding- to sheltered winter breeding areas. Although population parameters are well studied in some breeding grounds, far less is known about SRW foraging ecology, yet their reproductive success and thus population recovery are largely dependent on foraging success. Based on long-term sighting histories of individually identified females of the South African population of SRWs, the population is estimated to be increasing at an annual rate of 6.5%. However, in the past decade, this population has had an increased rate of reproductive failure, as well as a drastically decreased prevalence on their coastal wintering ground. Furthermore, a northward shift in foraging location has been detected between the 1990s to the 2010s concurrent with a significant decrease in female body condition. Here we aim to use long-term foraging records and endocrine patterns in whale baleen to understand how foraging ecology and reproductive success have co-varied over recent decades. We sub-sampled baleen plates of four females that stranded along the South African coast between 1987 and 2013. Plates were sampled at 2 cm intervals, representing approximately 1-mo sampling intervals. Stable carbon and nitrogen isotopes were used to understand migratory pathways of these four individuals via comparison to known isoscapes, with concurrent reproductive hormone analysis revealing individual pregnancies and inter-calving intervals over approximately decadal timespans for each individual. The working hypothesis is that, concurrent with altered foraging strategies, adult females failed to initiate or maintain gestation, indicative of poor
feeding conditions.

**Spotted and spinner dolphins sound different in mixed species schools: distinctive whistle types in an inter-species context**

Isha Shyam¹, Vincent Janik², Julie N. Oswald³

¹University of Plymouth, India, ²University of St Andrews, St Andrews, Fife, United Kingdom, ³University of St. Andrews, St Andrews, Fife, United Kingdom

Passive acoustic identification of cetaceans without associated visual observations is complicated by the occurrence of mixed-species schools. We investigated whistles of pantropical spotted dolphins (*Stenella attenuata*) and spinner dolphins (*Stenella longirostris*) to determine whether mixed-species schools (SaSl schools) produce whistles that are different from those produced by single-species schools (Sa schools and Sl schools). Whistle contours were extracted using the Real-Time Odontocete Classification Algorithm (ROCCA) and 39 time-frequency variables were measured from each (SaSl: n = 504 whistles, 19 schools; Sa: n = 554 whistles, 19 schools; Sl: n = 470 whistles, 16 schools). Contours were grouped into types based on frequency modulation patterns using artificial neural networks after dynamic time-warping in ARTWARP. This resulted in 291 types, with 136 containing three or more whistles. Of these, 37 contained whistles produced by only one class (class-specific whistle types, Sa: n = 15, Sl: n = 12, SaSl: n = 10). Whistle type usage varied between species. For example, 76% of class-specific whistles produced by Sa were upsweeps, compared to 50% for Sl and 0% for SaSl, and 32% of class-specific whistles produced by SaSl were flat compared to 0% for Sa and 7% for Sl. Upsweeps produced by Sl were significantly shorter (mean = 0.51± 0.21 s) than upsweeps produced by Sa (mean = 0.67 ±0.31 s, Games-Howell test, t = 0.161, p>.001). A random forest classifier using variables from all whistles correctly classified 66% of whistles and a random forest including only variables from class-specific whistles correctly classified 77% of whistles. Notably, correct classification scores increased from 61% to 96% for Sl and from 66% to 84% for SaSl when only class-specific whistles were used. These differences in whistle characteristics and whistle type usage may help to identify species, and particularly mixed species schools, in passive acoustic recordings.

**Do blast/acoustic trauma caused by explosions of World War II ammunition deposits have the potential to cause population effects in harbour porpoises?**

Ursula Siebert¹, Julian Stürznickel², Tobias Schaffeld³, Ralf Oheim³, Ellen Prenger-Berninghoff⁴, Peter Wohlsein⁴, Jan Lakemeyer⁷, Dominik Nachtshiem⁵, Tim Rolvien⁹, Michael Ameling¹⁰, Maria Morell¹¹

¹Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Buesum, Schleswig-Holstein, Germany, ²Department of Osteology and Biomechanics, University Medical Center Hamburg-Eppendorf, Hamburg, Germany, ³Institute for Terrestrial and Aquatic Wildlife Research (ITAW) Buesum, Büsum, Schleswig-Holstein, Germany, ⁴Department of Osteology and Biomechanics, University Medical Center Hamburg-Eppendorf, Hamburg, Germany, ⁵Institute for Hygiene and Infectious Diseases of Animals, Justus Liebig University Giessen, Giessen, Hessen, Germany, ⁶Department of Pathology, University of Veterinary Medicine Hannover, Foundation, Hannover, Germany, ⁷Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Büssum, Schleswig-Holstein, Germany, ⁸Institute for Terrestrial and Aquatic Wildlife Research, University of Veterinary Medicine Hannover, Büssum, Germany, ⁹Ham, Germany, ¹⁰University Medical Centre Hamburg-Eppendorf, Hamburg, Germany, ¹¹Institute for Terrestrial and Aquatic Wildlife Research
Harbour porpoises are under pressure of increasing human activities. This includes also ammunition which has been dumped into the seas during and after World War II in large amounts. Due to corrosion but also because of offshore activities mines needed to be removed. 42 British ground mines from World War II were cleared by means of blasting in the period from August 28 to August 31 2019 by a NATO unit in the German Exclusive Economic Zone within the MPA Fehmarnbelt in the Baltic Sea. A total of 24 harbour porpoises found dead between September and November 2019 in waters of the federal state Schleswig-Holstein were investigated for direct and indirect effects of blast trauma. Extended systematic investigations were conducted including brains, air-filled organs (lungs and gastrointestinal tract) and the acoustic organs, which include the melon and acoustic fat in the lower jaw as well as the ear and its surrounding tissues. Bone structure of the tympano-periotic complexes were examined using high-resolution peripheral quantitative computer tomography (HR-pQCT, XtremeCT®, XtremeCT II®). Based on microfractures of the malleus, dislocation of middle ear bones, bleedings and haemorrhages in the melon, lower jaw and peribullar acoustic fats, eight out of 24 harbour porpoises died due to a blast/acoustic trauma. In addition, one other animal, which was bycaught, and another one, which showed signs of blunt trauma, also exhibited signs of blast trauma. Especially due to the vulnerability of harbour porpoises in the Baltic Sea the noise mitigation concept must be improved to prevent any risk of injury. Moreover, the relevance of systematic investigations on the acute and chronic effects of acoustic trauma on harbour porpoises to understand the effects of underwater noise events in harbour porpoise bycatch, but also in population health in general. Without knowledge of the impact of underwater noise, it is difficult

**Estimating Marine Mammal Bycatch in the Icelandic Lumpsucker Fishery**

Gudjon Mar Sigurdsson¹, Gísli Vikingsson², Sandra Granquist³
¹Marine and Freshwater Research Institute, Reykjavik, Iceland, ²Marine and Freshwater Research Institute, Hafnarfjörður, Iceland, ³Marine and Freshwater Research Institute, Hvammstangi, Iceland

The fishery for lumpsucker (*Cyclopterus lumpus*) is a small-scale gillnet fishery conducted in the spring and summer in Icelandic coastal waters. While small-scale, the fishery provides valuable employment and economic stimulant to fragile coastal communities from where the fishery is conducted. The fishery had its MSC certification suspended in 2018 due to bycatch of several species of marine mammals and seabirds and the potential that the fishery could be hindering the recovery of those species. The suspension led to an increased monitoring to estimate bycatch in this fishery which then led to recertification of the fishery with some substantial requirements to fulfill. In this study, bycatch of marine mammals in this fishery was estimated using data from 296 onboard inspector trips over a five-year period, 2014-2018. Raised estimates were then contrasted with reports from vessel logbooks. The effect management area, fishing depth and month was also estimated. Overall bycatch rates were 1.07 marine mammals per trip, relatively high rates compared to other gears/areas. Reported bycatch in logbooks was around 4 times lower. The most bycaught species were harbour seal, grey seal, harbour porpoise, and harp seal while two rarer vagrant seal species, ringed seals, and hooded seals, were also caught. No significant effect of fishing depth or month was observed for any of the marine mammal species, while management area had a significant effect. The fishery is unlikely affecting the populations of harbour porpoise and harp seals, while it could potentially affect the populations of harbour seals and grey seals which have both been declining
since the 1980s. These declines warrant further research into bycatch monitoring and mitigation in this fishery.

Low-Frequency Hearing and Masking in Seals

Jillian Sills¹, Brandi Ruscher-Hill², Brandon Southall³, Ryan Jones⁴, Colleen Reichmuth⁵
¹University of California Santa Cruz, Skillman, NJ, ²University of California Santa Cruz, Santa Cruz, CA, ³Southall Environmental Associates, Inc., Aptos, California, ⁴UC Santa Cruz, Santa Cruz, CA, ⁵University of California Santa Cruz and Alaska SeaLife Center, Santa Cruz, California

The most pervasive auditory effect of aquatic noise is likely to be masking, in which an animal’s ability to hear sounds of interest is reduced by the presence of overlapping noise in the environment. Masking is a concern for marine mammals due to their reliance on acoustic information for orientation, conspecific communication, foraging, and predator avoidance. To understand and predict masking from any noise source, data are needed to parameterize the auditory capabilities of potential listeners. However, there are few auditory data available at very low frequencies, which prohibits an accurate consideration of the effects of industrial and ship noise on hearing in marine mammals. In this study, behavioral methods were used to examine low-frequency hearing in two trained bearded seals (Erignathus barbatus). We evaluated hearing sensitivity in quiet conditions, hearing in the presence of background noise, and auditory filter characteristics between 63 and 400 Hz. The resulting auditory parameters provide the first comprehensive hearing measurements available for any pinniped below 100 Hz, and enable evaluation of low-frequency masking by complex and naturally occurring sounds in the marine environment. These measurements demonstrate expected patterns based on auditory thresholds and critical ratio measurements obtained at higher frequencies for bearded, spotted, harbor, and ringed seals, and indicate that seals likely use the auditory sense (rather than the vibrotactile sense) to perceive sound frequencies > 63 Hz. This study improves understanding of masking in seals—which have the best demonstrated low-frequency hearing abilities among marine mammals. It also provides insight into masking in other presumed low-frequency specialists, including many whales requiring high levels of protection due to their threatened or endangered conservation status. Ultimately, these data support quantitative considerations of masking caused by specific low-frequency noise sources in realistic environments. [Supported by OGP JIP on Sound and Marine Life].

Exploring the use of seabirds as dynamic ocean management tools to mitigate entanglement risk to large whales

Tammy Silva¹, Kevin Powers¹, Michael A. Thompson², Jooke Robbins³, Alexandre Zerbini¹, Regina Asmutis-Silvia³, Alex Hill⁴, Laura Howes⁵, Dianna Schulte⁶, David Wiley⁷
¹Stellwagen Bank National Marine Sanctuary, Scituate, MA, ²Center for Coastal Studies, Provincetown, Massachusetts, ³Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA, ⁴Whale and Dolphin Conservation, Plymouth, MA, ⁵Dolphin Fleet and Center for Coastal Studies, Provincetown, ⁶University of Massachusetts Boston/Boston Harbor City Cruises, Weymouth, MA, ⁷Blue Ocean Society for Marine Conservation, Portsmouth, New Hampshire, ⁸Stellwagen Bank National Marine Sanctuary, NOAA National Ocean Service, Scituate, MA

U.S. management actions to reduce entanglement-related serious injury and mortality to large whales have been ineffective, partially due to static protection schemes that fail to account for distribution shifts of highly mobile animals. Effective large whale conservation would benefit from dynamic ocean management
DOM, but few tools exist to inform dynamic approaches. Seabirds are often found in association with whales and can be tagged at lower cost and in higher numbers than whales. We explored the use of satellite-tagged seabirds (great shearwaters, *Ardenna gravis*; hereafter shearwaters) as DOM tools for near real-time identification of habitats where humpback whales (*Megaptera novaeangliae*) aggregate and overlap with fisheries. We identified shearwater habitat use areas with 50% kernel density utilization distributions in the Gulf of Maine, at yearly, monthly, and weekly scales using satellite-telemetry data from 2013-2018. We quantified overlap using sightings and satellite telemetry data at two spatial scales: Stellwagen Bank National Marine Sanctuary (2180 km²) and the Gulf of Maine (93000 km²). At the sanctuary scale, there was ≥ 90% overlap with whales in 4/4 years (100%), 11/15 months (73%), and 37/60 (62%) weeks. At the Gulf of Maine scale, shearwater use areas encompassed humpback use areas (50% utilization distribution) in 2/3 (66%) years and 7/15 (47%) months analyzed. These initial results demonstrate that satellite-tagged shearwaters can be dynamic indicators of humpback whale habitat use in both space and time. With further study, tagged shearwaters may provide near-real time information necessary to operationalize dynamic management to more strategically mitigate human impacts on large whales.

Understanding energy-mediated responses of sperm whales to environmental shifts using a bioenergetic modelling approach

*Mariana Silva¹, Cláudia Oliveira², Rui Prieto³, Monica Silva⁴, Leslie New⁵, Sergi Pérez-Jorge⁶

¹OKEANOS Research Center - University of the Azores, Portugal, ²IMAR – Institute of Marine Research, Horta, Portugal, ³MARE – Marine and Environmental Sciences Centre; IMAR Centre at the University of the Azores, Horta, Portugal, ⁴IMAR – Institute of Marine Research & Okeanos Center - University of the Azores, Horta, Portugal, ⁵Washington State University, Vancouver, WA, ⁶Okeanos R&D Centre, Institute of Marine Research, University of the Azores, Horta (Fial - Azores, Portugal, Portugal*

Determining how animals allocate their energy, and how external variables influence this allocation, is crucial to understand the life history requirements and response to disturbance of populations. This response is driven in part by an individual’s energy balance, which is itself driven by prey characteristics, foraging behavior and the amount of energy required for essential functions. We developed a model to estimate the minimum foraging success rate of sperm whales (*Physeter macrocephalus*) based on their theoretical energetic requirements and using foraging data and prey characteristics from animal-borne tags and stomach contents, respectively. We used this model to simulate two environmental change scenarios, 1) decreased prey size (lower caloric content), and 2) missed foraging opportunities (lower prey availability). We estimate that sperm whales need a minimum of 40% foraging success rate to meet their energetic requirements, and that foraging success rates are more sensitive to changes in prey size than to changes in prey availability. To estimate sperm whale vulnerability to a reduction in energy intake, we evaluated how much whales would have to compensate this reduction by looking at the ratio of energy requirements to energy acquired. Considering a minimum foraging success of 40%, the whales would need to increase their energy intake by 14% (2-26%) and 41% (26-56%) to compensate a decrease of 15% and 30% in prey size, respectively. For a decrease of 30% and 50% in prey availability, whales would need to increase energy intake by 12% (0-24%) and 20% (7-33%) to meet their energetic, respectively. In the future we will use information of animal-borne tags to explore sperm whale capacity to compensate for energetic losses. Our results link environmental changes to energetics, improving the understanding of sperm whales’ response to
Variation in morphology among blubber histology metrics when assessing nutritional status in a False killer whale (Pseudorca crassidens)

Ilse Silva-Krott1, Jana Phipps2, Jamie Marchetti3, Kristi West4
1Honolulu, HI, 2University of Hawaii at Manoa, Health and Stranding Lab, Honolulu, HI, 3NOAA NMFS Pacific Islands Region Observer Program, Honolulu, HI, 4University of Hawaii, Kaneohe Bay, HI

Blubber is a multifunctional tissue essential to the survival of cetaceans. Histological assessment of blubber may be useful in determining odontocete nutritional state but a greater understanding of specific variation across the body is needed. We report on morphological variation in adipocyte area (AA) and adipocyte index (AI) among blubber layers and according to girth axes and sampling planes in a sub-adult male, by-caught false killer whale (Pseudorca crassidens). Full-depth blubber sampling was conducted along 5 equidistant sampling points on both sides of the body at 5 girth axes based at major anatomical landmarks. 40 H&E slides of blubber tissue were examined and photographed under 10x magnification. Outer, middle and inner blubber layers were defined by morphology and adipose/fibrous connective tissue ratios. AA and AI were determined for each layer at each location using ImageJ. An inverse relationship between all AA and AI measurements in the individual was statistically significant based on linear regression analysis ($R^2 = 0.68$). Significant differences by multiple comparisons were apparent between blubber layers with the lowest AA and highest AI observed in the outer layer, the middle layer with highest AA and lowest AI, and the inner layer with intermediate values in both. AA was greater cranially with significant differences among girth axes for all blubber layers. AI was higher caudally with significant differences only in the outer blubber layer.

Comparisons of AA and AI across dorso-ventral sampling planes indicated significant variation of AI in middle and inner layers and AA in the inner layer. Results demonstrated morphological differences in blubber depending on layer and body location with less overall variability in the middle layer. This highlights the importance of identifying blubber layer when examining nutritional status and suggests that middle layer AA and AI may be the most useful for assessing body condition.

Repeated call production of long-finned pilot whales during mass stranding events: evidence for individually specific calls

Anna Silverstein1, Peter Tyack2, Jessica Magolan1, William Lange1, Laela Sayigh1
1Mount Holyoke College, Brooklyn, NY, 2University of St Andrews, St Andrews, 3Harte Research Institute for Gulf of Mexico Studies, Texas A&M University-Corpus Christi, Texas, 4Woods Hole Imaging Systems, Woods Hole, MA, 5Woods Hole Oceanographic Institution/Hampshire College, Woods Hole, Massachusetts

Surprisingly little is known about the communication signals of pilot whales (Globicephala sp.). Both short-finned (Globicephala macrorhynchus) and long-finned pilot whales (LFPW; Globicephala melas) produce repeated, stereotyped calls, which sometimes occur in repetitive sequences, but little is known about how these calls function. A major challenge in studying pilot whales is that they tend to occur in large groups, making it very difficult to attribute sounds to specific individuals. We analyzed vocal production during two LFPW stranding events that took place in Massachusetts in the early 1990’s. We hypothesized that if pilot whales produce individually distinctive sounds, the stranding context would promote production of these
sounds, given that bottlenose dolphins tend to produce large numbers of individually distinctive signature whistles when isolated from conspecifics. Calls were visually classified into categories by two independent observers, and these categories were supported by Linear Discriminant Analyses that incorporated frequency parameters (minimum, maximum, bandwidth) and duration. From 290 calls classified from the approximately one hour recording from the first stranding event, 10 call types were identified, with all but one occurring at least 11 times (mean = 29; range = 6 - 61). These calls occurred more-or-less sequentially throughout the recording, which is consistent with the idea that each was produced by a different animal as the recordist walked down the beach. For the second stranding, most of the approximately two hour recording focused on a single individual, and all of the calls during this period (n=959) were classified as one call type. A second call type was identified toward the end of the recording (n=43), when the transcript indicated that a second individual was being recorded. These results provide the first indication that pilot whales, like many other delphinid species, may produce individually distinctive sounds.

Unexpected spy-hopping in Chilean dolphins: are they really spying?
Margherita Silvestri1, George Swan2, Sonja Heinrich3, Mauricio Soto-Gamboa4
1Universidad Austral de Chile (UACh), Chile, 2Facultad de Ciencias Forestales y Recursos Naturales, Universidad Austral de Chile, 3Sea Mammal Research Unit, University of St Andrews, UK, 4Instituto de Ciencias Ambientales y Evolutivas, Facultad de Ciencias, Universidad Austral de Chile.

Observing behaviour and its social context can provide important insights into a species’ ecology but has been limited by logistic challenges of accessing and recording free-ranging cetaceans. Here we report preliminary observations of the social context of spy-hopping behaviour (SHB) in a poorly studied coastal delphinid, Chilean dolphins (Cephalorhynchus eutropia). We conducted focal group observations from a shore-based vantage point overlooking the estuary of the Valdivia River in southern Chile (39.9S, 73.4W) from November 2021 to January 2022. Data were collected using a digital video camera and on 4 occasions simultaneous recordings were obtained with an unmanned aerial vehicle (UAV) flown above at a minimum altitude of 20 meters from the sea surface. We recorded the frequency and duration of SHB, the number of individuals involved in this behaviour, the presence of calves or juveniles, and the main behavioural activity of the group (Foraging, travelling, socializing and resting). We recorded a total of 12 SHB events in 155.6 hours of land-based sampling (0.8 event/hour), with a mean duration of 17 s (SD = 11, n = 10, UAV effort = 2.10 hours). In a large fraction of the observations, SHB was performed by a single individual (90 %) and the maximum number of individuals performing SHB simultaneously was two. We mostly observed SHB behaviour in relative large groups, with calves and juveniles (n = 9, mean duration = 15 s, SD=8, Group size>15) and never during travelling behaviour. In other cetacean species, SHB has been associated with multiple contexts and functions such as orientation or socializing. However, to understand the ecological role of SHB in Chilean dolphins, further studies are needed. Although preliminary, these results show the existence of a surface display never recorded for this species before.

Interactions between harbour porpoises and aquaculture on the west coast of Scotland
Texa Sim1, Steven Benjamins2, Caroline Carter3, Ben Wilson2
1Scottish Association for Marine Science, United Kingdom, 2Scottish Association for Marine Science, Oban, Argyll and Bute, United
The nature and extent of interactions between cetaceans and aquaculture are largely unexplored. Individuals may face a trade-off between potential benefits, such as foraging opportunities, and the possibility of negative consequences from exposure to industrial activities. In Scotland, the expanding Atlantic salmon (Salmo salar) farming sector is mainly located on the west coast and among the northern and western isles, which also host some of the highest densities of harbour porpoise (Phocoena phocoena) in Europe. The region’s importance for the species is recognised by the Inner Hebrides and the Minches Special Area of Conservation (SAC). From 2018 to 2020, Passive Acoustic Monitoring (PAM) was conducted using click loggers at eight salmon farms within the wider Firth of Lorn, to determine whether porpoises interact with farms on Scotland’s west coast. The results indicated that porpoise presence around the salmon farms was site-specific, however modelling using GAM-GEEs revealed detection probabilities were most strongly correlated to environmental parameters such as sun altitude, diel hour, and water temperature. Other environmental parameters, including wind speed, water salinity, in addition to daily and monthly tidal cycles, also influenced detection probability. During the study, the salmon farm soundscape was simultaneously recorded and explored to characterise the sector’s noise emissions. It was found that stocked salmon farms produce a broad range of sounds, many of which can be ascribed to specific activities carried out as part of normal farm maintenance operations. Spectral analyses revealed the distinctive acoustic characteristics of various operations, including air-driven fish feeder systems, electricity generators, acoustic deterrent devices (ADDs), vessel use, and net cleaning activities. The present study affirms that harbour porpoises are regularly present near salmon aquaculture farms on the west coast of Scotland, and offers a broad examination of the sector’s relevance to this vulnerable cetacean species in an internationally important conservation region.

Success in the First Two Years of the Rare Pinniped Conservation Network (RAPCON)
Samantha Simmons¹, Jason Baker², Laura Boren³, Brady O'Donnell⁴
¹SMRU Consulting, Harrogate, United Kingdom, ²Protected Species Division / NOAA / PIFSC, Honolulu, HI, ³New Zealand Department of Conservation, Wellington, North Island, New Zealand, ⁴Marine Mammal Commission, Bethesda, MD

The pinniped clade comprises 33 extant species and numerous subspecies widely distributed throughout the globe. Historically decimated by unsustainable killing, many pinniped species and populations have rebounded. However, according to the IUCN Red List of Threatened Species, about 10% of pinniped species are listed as VU (vulnerable) and approximately one-fifth are considered EN (endangered). A primary challenge of conserving small populations is that anthropogenic and natural threats can wreak profound negative population-level impacts. Rare pinnipeds have relatively small populations by definition, but also often occupy small geographic ranges, making them more vulnerable to localized threats. However, a positive aspect of conserving small populations is their tractability for intervention to mitigate threats and achieve positive population-level outcomes by intervening on a small (even individual seal) scale. When lessons learned from both successful and unsuccessful interventions can be shared among the dedicated groups working to conserve rare pinnipeds, the benefits can be increased exponentially. RAPCON was established during a workshop at the World Marine Mammal Conference in Barcelona to foster organization and sustained collaboration among individuals working to conserve rare pinniped populations.
globally. Here we report on the growth and development of the network over the past two years highlighting successes and lessons learned. A RAPCON Facebook group with over 60 members from at least 14 countries has served as a hub for communication. Post topics have encompassed project updates, sharing new publications, questions about odd seal behaviors or injuries, notable sightings, and more. Several collaborations among specialists working on different species were sparked during the Barcelona workshop and have developed thereafter. RAPCON continues to mature and holds tremendous promise to enhance connectivity among a core group of conservationists working to improve the status of rare pinnipeds globally.

Assessment of the Recommendation that People not “Swim” with Wild Dolphins

Eric Simon, Lighter-than-Pain Productions

Tours offering “swimming” with wild dolphins, or better described as dropping people in the water in the vicinity of wild dolphins, have fallen into a kind of regulatory limbo, where, on the one hand, the National Oceanic and Atmospheric Administration’s marine life viewing guidelines call on people to please not swim with wild dolphins, while, on the other hand, the regulatory language of the Marine Mammal Protection Act only goes so far as to prohibit “harassment” of marine mammals, leaving “harassment” up to interpretation. With boat tours offering “swimming” with wild dolphins happening currently in only a couple locations in the U.S., opportunities to collect meaningful data that actually separate the effects from people being in the water near wild dolphins from the effects of boat traffic are limited. This paper consists of an overview of all the findings so far on this topic to indicate whether the NOAA’s viewing guidelines are justified, or whether the data collected so far do not allow us yet to make any definitive determination on the impact of human presence in the water near wild dolphins, provided that a certain etiquette can be followed, such as avoidance of touching, feeding and swimming towards dolphins, and that certain constraints are placed on the volume of human activity.

Harbor porpoises are displaced or reduce echolocation activity following fisheries-related explosions in Monterey Bay

Anne Simonis¹, Cory Hom-Weaver¹, Karin Forney², Tetyana Margolina³, John Joseph⁴, John Ryan⁵, Andrew DeVogelaere⁶, Shannon Rankin⁷
¹NOAA National Marine Fisheries, San Francisco, California, ²NOAA, NMFS, Southwest Fisheries Science Center, Moss Landing, California, ³Monterey, CA, ⁴Naval Postgraduate School, Monterey, CA, ⁵Monterey Bay Aquarium Research Institute, ⁶Monterey Bay National Marine Sanctuary, ⁷NOAA Fisheries, Southwest Fisheries Science Center, La Jolla, California

Small explosives (“seal bombs”) are used in some California purse seine fisheries to deter depredation by pinnipeds or to aggregate catch. Nearby cetaceans can also be exposed to high-intensity impulses from these explosions and subsequently experience indirect impacts. Harbor porpoises are known to be particularly sensitive to anthropogenic sound, and the small, localized population in Monterey Bay, California may be vulnerable to adverse impacts associated with displacement or disruption of foraging. To investigate the response of harbor porpoises to explosions, we collected acoustic recordings over six months (August 2019 – February 2020) from seafloor moorings at five locations throughout Monterey Bay. Explosions and harbor porpoise echolocation clicks were automatically detected and manually reviewed in Pamguard software. High levels of echolocation activity was evident in known important harbor porpoise habitat within Monterey Bay. Explosions predominantly occurred at night and often co-occurred with acoustic detections of harbor porpoises, although harbor porpoise echolocation activity was
significantly reduced 10 minutes, 1 hour, 1 day, and up to two days following explosions (permutation tests, p<0.001 for all time windows examined). A series of the same explosions was detected on multiple instruments throughout Monterey Bay, and site-specific transmission loss models were used to explore the potential source location and detection distances. We assessed the intensity and spectral characteristics of explosions in relation to harbor porpoise hearing, as well as the existing and proposed guidelines for the use of explosives in fisheries.

Evaluating The Utility Of Protected Species Observer Data To Address Cetacean Management And Conservation

Nick Sisson¹, Laura Ganley², Jessica Redfern³
¹NOAA Greater Atlantic Regional Fisheries Office, ²Burlington, Massachusetts, ³Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, Massachusetts

Protected Species Observers (PSOs) are used worldwide to monitor and protect marine mammals and sea turtles during anthropogenic activities. These observers play an important role in species monitoring and mitigation, but they also collect a broad suite of data that have the potential to expand our understanding of species distributions, the effectiveness of mitigation measures, and the effects of anthropogenic activities on protected species. The Massachusetts and Rhode Island wind energy areas (WEAs) represent an important opportunity to evaluate the use of PSO data because data collection in these areas has occurred during a similar time window as systematic, line-transect aerial surveys. PSO data has been collected between 2016-2021 from eight different offshore leases in these WEAs and includes more than 1,527 sightings of 13 cetacean species, including North Atlantic right whales. Since 2011, aerial surveys in these WEAs have collected over 1,000 sightings of 12 cetacean species on more than 75,000 kilometers of transect lines. The goals of this research are to summarize the PSO data available in the WEAs and compare it with data collected by the systematic aerial surveys to understand the potential benefits and limitations of PSO data. Comparisons start with identifying the number of cetacean species seen in different survey months and evaluating temporal trends in sightings rates for each data set. We also assess how PSO data sample sizes affect the analyses that can be successfully conducted; analyses evaluated range from estimating abundance to developing species distribution models to estimate the probability of occurrence. The results of our project include recommendations about how PSO data can be collected to provide the greatest conservation value while maintaining species protection measures as the primary duty for the PSOs and recommendations about how PSO data can be utilized for regulatory/management and scientific purposes.

An agent-based approach to estimating marine mammal bycatch

Liz Slooten¹, Scott Meyers², Jacob Nabe-Nielsen³
¹Otago University, Dunedin, New Zealand, ²University of Central Florida, Orlando, Florida, ³Department of Bioscience, Aarhus University, Roskilde, Denmark

An agent-based approach is ideal for estimating bycatch and taking into account the effect of marine mammal movement on bycatch. The movements of dolphins, trawling vessels and gillnets can be explicitly modelled, to estimate the overlap between marine mammals and fishing gear that causes marine mammal bycatch. In this case study, movement of Hector’s and Maui dolphins among populations and between protected and unprotected areas substantially increases the bycatch estimate (by at least 150%). Bycatch estimates from this analysis, which uses offshore dolphin distribution data from population surveys, are compared with results from a habitat model (based on water turbidity) used by the Ministry for Primary Industries for
estimating the overlap between dolphins and fishing. The government approach targets protection in areas where high densities of dolphins and high fishing effort coincide, leaving the smallest, most vulnerable populations poorly protected. This increases the risk of local extinctions, causes population fragmentation, a loss of genetic variability and results in increased risk to the species as a whole. Much more effective protection measures can be designed by focusing on the impact of bycatch on small, local populations – starting with small population units and building from there, in order to design sustainable management at a larger spatial scale. These findings have direct application to many other marine mammal bycatch problems. The U.S. Import Rule has resulted in creative, novel solutions, including this work using an agent-based approach.

Development and Characterization of a Non-Antibiotic Antimicrobial Polydopamine Surface Coating for use in Marine Mammal Conservation

Ariana Smies1, Jeremy Wales1, Maureen Hennenfent1, Bruce Lee1, Jooke Robbins2, Alexandre Zerbini3, Rupak Rajachar3

1Kohler Co., Houghton, MI, 2Center for Coastal Studies, Provincetown, Massachusetts, 3Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA

For years, skin penetrating devices (e.g. telemetry tags and biopsy tools) have been used to improve cetacean conservation. Many of these devices utilize retention elements that penetrate the dermis and the underlying tissue which can increase the risk for infection and subsequent tissue necrosis. At present, to mitigate infection, antibiotic coatings are used as a precautionary measure. However, there is growing concern about potentially antibiotic resistant pathogens due to the overuse of antibiotics. We have developed a non-antibiotic antimicrobial surface coating to prevent bacterial adhesion and subsequent infection with the potential to also improve wound healing outcomes. To prevent infection without the use of antibiotics, we synthesized an optimized polydopamine (pDA) surface coating which, when exposed to oxygen, releases controlled localized doses of the reactive oxygen species hydrogen peroxide ($\text{H}_2\text{O}_2$). $\text{H}_2\text{O}_2$ has been found to act as an antimicrobial against pathogens as well as play an important role in the wound healing response. We first synthesized and characterized our pDA coating to establish uniformity as well as to evaluate if the $\text{H}_2\text{O}_2$ release profile could be tailored. We found that, based on the temperature and pH of the coating solution, we could create surface coatings with two different release profiles: low release (~20uM) and high release (~80uM). Next, we evaluated the ability for our coating to prevent bacterial adhesion to the surface of medical grade stainless steel. Our high release coating was able to substantially reduce the adhesion of one of the most common bacterial genera, *Psychrobacter*, which is found on the skin of healthy cetaceans by approximately 80%. After confirming antimicrobial character, preliminary results confirmed our pDA surface coatings are also non-cytotoxic. Our coatings have the potential to prevent infection as well as enhance wound healing outcomes when applied to the surface of any device that penetrates the skin barrier.

A review of interactions between sharks and stranded marine mammals off the northeastern United States.

Ainsley Smith1, Emily Brown2, Tobey Curtis3, Ellen Keane3, Meredith Moise4, Mendy Garron5

Sharks are important predators and scavengers of marine mammals, but there has been little study on their ecological dynamics off the northeastern United States. In particular, as white shark (Carcharodon carcharias) and gray seal (Halichoerus grypus atlantica) populations recover on the east coast of the United States, there is heightened awareness of their predator-prey relationship by the general public, beachgoers, and coastal communities that rely on summer tourism. Local media highlights these interactions each summer as white sharks are seen near popular beaches, and some members of the public have responded by proposing drastic mitigation measures or to cull the population of both species. To increase understanding of historical shark presence in NOAA’s Greater Atlantic Region (GAR), Maine through Virginia, we examined over 20 years of records in NOAA’s Marine Mammal Health and Stranding Response Program’s database for indications of shark interaction with live stranded marine mammals or scavenging on carcasses. These records were analyzed and mapped to describe presence/absence, location trends, and frequency of interactions documented to support current shark research, future data collection and analysis, and public outreach. Interactions between sharks and marine mammals have occurred across the entire range from Maine through Virginia, and data analysis reveals that documented interactions have increased since the 1990s. Interactions between sharks and seals were further examined, and results will be used to target increased public awareness and understanding of sharks and their role in the GAR ecosystem. We thank the GAR Stranding Network for responding, collecting and providing the data used in this study.

**Development of the Next Generation Tag and Buoy for Tracking Whale Entanglements**

Jamison Smith¹, Thomas Dempsey², Aliya Rubinstein², Matt Merrifield², Greg Pronko³, Mike O'Reilly⁰

¹Blue World Research Institute, Cocoa, FL, ²The Nature Conservancy in California, Sacramento, California, ³Level 2 Industries, San Francisco, California

The accidental entanglement of whales in marine debris and fishing gear is one of the primary sources of human-caused whale serious injury and mortality globally and is a growing problem. Entanglements also significantly impede population recovery of endangered species, and have been implicated as a major factor in the decline of North Atlantic right whales (Eubalaena glacialis). While there are significant efforts led by numerous organizations and agencies around the globe to help free entangled whales, especially in the United States, response teams are limited by outmoded tools and technology to relocate the entangled animals.

This project is the culmination of a collaborative 3-year effort to build a tracking tool that incorporates the major advances we’ve seen in hardware and software technology over the last decade. We’ve explicitly re-designed the size and shape of the buoy and tag to optimize for various factors including minimizing drag and maximizing visibility. We’ve re-engineered the electronics to take advantage of technologies that have become commonplace with the maturity of IoT (Internet of things). This includes small, low-cost, and powerful computing on the device as well as GPS, and satellite modems for capturing and communicating high-resolution geospatial data rapidly. These data can be accessed securely by both response teams in the field and response coordinators in offices. Having rapid access to these data will significantly reduce the amount of time response teams spend scouting for tagged whales.

Ultimately, this tool may improve outcomes for whales and ocean health by (1) better supporting entanglement response teams in relocating whales more quickly through improved data
access, (2) reducing the risk of exacerbating serious injury/mortality to whales through its reduced drag and design, and (3) increasing the potential to recover the buoy and any attached entangling gear through its maximized visibility and greater lifting force.

**Historic foraging preferences of blue and fin whales in the Southern Ocean**
Malia Smith¹, Alyson Fleming²
¹University of North Carolina Wilmington, Wilmington, NC, ²University of North Carolina Wilmington

Southern hemisphere blue (*Balaenoptera musculus*) and fin (*Balaenoptera physalus*) whales share several similarities in morphology, physiology, and distribution, but understanding of their life history and foraging is limited due to their low population abundances and lack of historic and modern ecological data. The purpose of this study was to examine the historic population and foraging dynamics of blue and fin whales from Japanese whaling in the Southern Ocean. Baleen plates from 1947 and 1948 from blue (n = 5) and fin (n = 5) whales were sampled from the Smithsonian National Museum of Natural History as a pilot study to inform further research on a recently rediscovered extensive collection of blue and fin whale baleen plates. The samples were analyzed for bulk ($\delta^{13}C$ and $\delta^{15}N$) and compound-specific ($\delta^{15}N_{AA}$) stable isotope analyses. Oscillations observed from the bulk data show that blue whale baleen plates contain approximately eight years of life history data while fin whale baleen records about five years. Analyses of isotope signatures from these plates suggest that: 1) blue whales appear to reside year-round in the Southern Ocean ($\delta^{13}C$: -24.6‰±1.0‰), while fin whales likely migrate to sub-Antarctic waters ($\delta^{13}C$: -20.8‰±0.8‰) during the austral winter, 2) blue and fin whales feed at the same trophic level but in different habitats, and 3) blue and fin whales have isotopically different habitats in both winter and summer. The $\delta^{15}N_{AA}$ values indicate that temporal changes in bulk $\delta^{15}N$ values are likely due to ecosystem baseline shifts rather than prey switching. These results suggest niche partitioning between blue and fin whales and differences in life history strategies. This historical data provides a better understanding about potential factors that may continue to shape the migration and foraging dynamics of these whales.

**Toothed whale auditory evoked potentials measured with a non-invasive, on-animal tag**
Adam Smith¹, Peter Teglberg Madsen², Mark Johnson³, Peter Tyack⁴, Magnus Wahlberg⁵
¹University of Southern Denmark, Denmark, ²Aarhus university, ³Aarhus Institute of Advanced Studies, Aarhus University, Denmark, ⁴University of St Andrews, St Andrews, ⁵Marine Biological Research Centre, University of Southern Denmark, Kerteminde, Funen, Denmark

Hearing is a vital sensory modality for echolocating odontocetes and a fundamental component of understanding their natural behavior and assessing potential impacts of anthropogenic noise. Yet empirical measurements of odontocete hearing are limited to captive individuals, constituting a small fraction of species across the suborder. Data from more species would be available if empirical hearing measurements could be collected from unrestrained animals in the wild. As a step towards this, we investigated if a non-invasive, animal-attached tag could be used to record auditory brainstem responses from a trained harbor porpoise (*Phocoena phocoena*). The porpoise was asked to either station on an underwater biteplate or complete a swimming target-approach task. Trials for both tasks were completed in both the presence or absence of an externally-generated click stimulus. During the trials, a modified DTAG with non-invasive electrodes was attached to the porpoise’s back to collect electrophysiological and acoustic data.
Although recorded electrophysiological noise was greater during the swimming versus stationary trials, auditory brainstem responses were successfully measured during both tasks. The results demonstrate that auditory brainstem responses to acoustic stimuli can be measured from both a stationary and actively swimming odontocete using an animal-attached recorder and are comparable to data collected with a typical pool-side data acquisition system. With additional development and validation, tag-based electrophysiological platforms may ultimately facilitate the collection of hearing data from freely-swimming odontocetes in the wild.

Non-releasable factors and permanent placement trends for stranded marine mammals within the United States (2012-2021)

Courtney Smith¹, Jennifer Skidmore², Sarah Wilkin³, Deborah Fauquier⁴, Amy Sloan²
¹Ocean Associates, Inc. / NOAA, Washington, DC, ²NOAA Fisheries Office of Protected Resources, Silver Spring, MD, ³National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD, ⁴NOAA Fisheries

The National Marine Fisheries Service (NMFS) Marine Mammal Stranding Network program attempts to successfully rehabilitate and release back to the wild each stranded marine mammal that is admitted, as intended by the Marine Mammal Protection Act. However, in some cases, the attending veterinarian of the rehabilitation facility may determine that the release of a rehabilitated marine mammal is unlikely to be successful given the physical condition, age, and/or behavior of the animal, as outlined in the NMFS Marine Mammal Release Criteria. In these cases, NMFS may deem these marine mammals non-releasable and place them with a permanent care facility for the purposes of public display, research, enhancement, or national defense. Over the last decade (2012-2021), 195 marine mammals representing 14 unique species (5 cetaceans and 9 pinnipeds) were deemed non-releasable and recommended for permanent placement. This analysis identifies causes for non-releasable determinations; the purposes for non-releasable placements; and factors influencing placement timelines and facility acquisitions. Understanding these underlying trends will better inform stranding partners, recipient facilities, and NMFS managers regarding future rehabilitation and placement efforts.

Fecal aldosterone as a complementary biomarker of the stress response in dugongs (Dugong dugon)

Laetitia Smoll¹, Tamara Keeley¹, Elizabeth Burgess², Janet Lanyon³
¹The University of Queensland, Camp Hill, QLD, Australia, ²New England Aquarium, ³University of Queensland, Brisbane

Fecal glucocorticoid metabolites are widely used to measure the stress response of mammals, but their role in other biological processes can make interpretation difficult; approaches that integrate multiple biomarkers may alleviate this issue. The mineralocorticoid aldosterone is increasingly used to investigate the physiological stress response in marine mammals as this adrenal hormone helps maintain water and electrolyte balance, a process crucial to survival. To determine whether fecal aldosterone metabolites (fALD) can be used to evaluate adrenal activation in dugongs, fALD concentrations were measured in samples collected from 222 wild dugongs of both sexes and all ages, from Moreton Bay, Queensland, Australia, from 2005-2018, using a commercially available enzyme immunoassay (Arbor Assays®, USA) and compared to previous measures of fecal cortisol (fGC). fALD concentrations were (weakly) positively correlated with fGC ($r_s(220) = 0.4$, $p < 0.0001$), potentially reflecting complementary secretion and activation of these hormones. There was a significant difference in
mean fALD concentrations between reproductively mature males and females (32.9 ± 11.5 ng/g and 26.6 ± 10.3 ng/g, respectively; Mann-Whitney U = 1201, p = 0.002). No sex difference was observed between immature individuals. All female dugongs had highest fALD concentrations in winter (29.6 ± 13 ng/g), and lowest levels in spring (24.2 ± 10 ng/g). In contrast, mature males in spring had the highest fALD levels of any demographic cohort (36.6 ± 12.8 ng/g), with levels dropping only slightly in winter (32.4 ± 8.1 ng/g). Considering its role in osmoregulation and that dugongs depend on seagrass for dietary water, aldosterone may help distinguish between the impacts of external stressors, including a decline in availability of nutrients, and internal physiological stressors such as reproductive events. Future studies will use contemporary seagrass abundance data to confirm this hypothesis and will investigate the potential influence of pregnancy (confirmed through fecal progesterone analysis) on fALD.

Diurnal activity of Ladoga ringed seal (Pusa hispida ladogensis Nordquist, 1899) on summer haulouts, Valaam Archipelago, Russia

Maria Sokolovskaya 1, Irina Trukhanova 2, Polina Bakunovich 1, Ksenia Strukova 4

1 Russian State Hydrometeorological University, Education and Scientific Station “Valaam”, Saint Petersburg, Russia, 2 North Pacific Wildlife Consulting LLC, Seattle, WA, 4 ICPO Biologists for nature conservation, Saint Petersburg, Russia, 5 Education and Scientific Station “Valaam”, Saint Petersburg, Russia

A study of Ladoga ringed seal haulout use pattern was carried out in June 2020 on the islands of the Valaam Archipelago, Lake Ladoga, where the largest summer haulouts of this subspecies are observed annually. Ten camera traps were set up on the coast of the four islands to overlook known large haulouts. The cameras collected imagery every 10 minutes, 24 hours a day. 198 camera trap-days resulted in almost 18,000 images with seals present in over 20% of them, either in the water, on the rocks or on the coast. The abundance of seals recorded by all traps combined ranged from 2 to 169 animals per day. The set of environmental covariates including wind speed and direction, wave height, precipitation, air temperature and presence of disturbance sources was developed to analyze the haulout use dynamics in relation to weather conditions. The daily dynamics of haulout formation was revealed. The animals would typically start approaching the haulout at night and leave the site due to changes in wind direction, increasing wind speed, or increasing wave height. In calm weather and in the absence of anthropogenic disturbance factors, the seals could stay on the haulout for more than a day, but the number of animals fluctuated significantly. We studied the pattern of coastline use by seals on different islands, identified the main types of the haulout formation, and the factors influencing these processes. The results obtained will allow unification of the methodology of local surveys of the Ladoga seal haulouts. This cost-effective approach might be further used to monitor the seal population status in Lake Ladoga. The study is implemented with the support of South-East Finland - Russia CBC Programme 2014-2020 funded by the European Union, the Russian Federation and the Republic of Finland.

Passive Acoustic Monitoring for Conservation: The Rice’s Whale in the Gulf of Mexico

Melissa Soldevilla 1, Ashley Cook 2, Amanda Debich 3, Kait Frasier 1, Lance Garrison 2, Adolfo Gracia 4, John Hildebrand 1, Joel Ortega-Ortiz 7, Arturo Serrano 8

1 Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL, 2 university of miami, 3 Cooperative Institute for Marine and Atmospheric Studies, University of Miami, Miami, FL, 4 Scripps Institution of Oceanography,
The newly recognized Rice’s whale (*Balaenoptera ricei*), the only resident baleen whale in the Gulf of Mexico, is one of the most endangered marine mammal species worldwide. This species faces a high risk of extinction due to its very small population size and limited distribution in the highly industrialized Gulf. Fundamental questions about where, when, how often, and why the whales occupy certain habitats need answering to recover this species and protect its habitat. To address these questions, we have developed a multi-scale passive acoustic monitoring program throughout the Gulf of Mexico. These efforts include a focused ship-based Rice’s whale ecology study conducted from 2018-2019, with directional sonobuoys deployed to validate the species’ call types. We verified the characteristic “long moan” calls, documented call rates, and estimated detection distances. Using this information, we’ve deployed a long-term moored HARP in their core habitat for 8 years to understand seasonal and interannual occupancy, providing evidence of near-constant year-round occurrence with some seasonal and interannual variability in call detections. These data can be used to explore relationships between Rice’s whale detections and oceanographic conditions. During 2021, we deployed a sparse Soundtrap array throughout the core habitat to investigate seasonal movements and spatio-temporal call density patterns. Exploration of their potential broader distribution and frequency of occurrence beyond their core habitat using moored HARPs along the shelf-break throughout the Gulf shows that they regularly use waters of the northwestern Gulf and produce different call types in this region; current studies are expanding this work to the southern Gulf. Finally, we are opportunistically exploring whether Rice’s whales occur in deep waters using HARP data from Gulf-wide studies of oceanic cetaceans. Combined, these passive acoustic studies provide crucial and timely information for developing critical habitat and recovery plans to save one of the most endangered whales.

Automated classification of beaked whale echolocation clicks of the Western North Atlantic using deep-learning neural networks

**Alba Solsona Berga**¹, Kait Frasier², Jennifer Trickey³, Liam Mueller-Brennan⁴, Chelsea Field¹, Taylor Ackerknect⁵, John Hildebrand², Joel Bell⁶, Danielle Cholewiak⁷, Sofie Van Parijs⁸, Simone Baumann-Pickering⁹

¹Scripps Institution of Oceanography, ²Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, ³Scripps Institution of Oceanography, San Diego, CA, ⁴Contractor, Northeast Fisheries Science Center, National Marine Fisheries Service, Oregon State University, East Falmouth, MA, ⁵Scripps, ⁶Naval Facilities Engineering Systems Command Atlantic, Norfolk, Virginia, ⁷Northeast Fisheries Science Center / NOAA Fisheries, Woods Hole, Massachusetts, ⁸NOAA NMFS NEFSC, Woods Hole, MA, ⁹Scripps Institution of Oceanography, UCSD, La Jolla, California

Passive acoustic monitoring has become an essential method in studying the ecology of beaked whale species. A monitoring program in the Western North Atlantic has collected acoustic data over five years across eleven monitoring sites to assess the effects of anthropogenic noise on beaked whales. The volume of data generated presents a challenge for classification to the species level as it requires expertise and time to manually label individual signals. We designed a system to streamline and automate the process of detecting and classifying echolocation clicks at the species level. We used a generic detector to
detect clicks above a received level threshold. We applied a deep-learning neural network to cluster and classify similar click types accounting for the variability within types and between sites. Unsupervised learning was used to derive clusters of distinct click types based on similarities in the spectral shape, inter-click interval, and click duration. The deep-learning network was trained on the clustered click types and applied to the large passive acoustic dataset for the classification task. Analysis results for six beaked whale species (Blainville’s, Cuvier’s, Gervais’, Sowerby’s, True’s, and the unknown Mesoplodon sp. designated as Beaked Whale Gulf) will be presented. This work provided the balanced need for efficient, fine-scaled analytical methods allowing efforts to be fostered towards our understanding of the acoustic behavior of beaked whales and anthropogenic activities.

The Southern Ocean Exchange: humpback whales are crossing putative boundaries in Antarctic feeding areas
Renata Sousa-Lima1, Ted Cheeseman2, Jennifer Jackson3, Ari Friedlaender4, Logan Pallin5, Marilia Olio6, Leonardo Liberali Wedekin7, Fábio G. Daura-Jorge8, Júlio Cardoso9, Joana Santos10, Roberto Fortes11, Márcia Araújo12, Manuela Basso13, Vicki Beaver14, Annette Bombosch15, Chris Clark16, Judith Denkinger17, Adrian Boyle18, Kristin Rasmussen19, Isabel Cristina Avila20, Daniel M. Palacios22, Amy Kennedy23, Milton Marcondes24
1Laboratório de Bioacústica, Departamento de Fisiologia e Comportamento, Universidade Federal do Rio Grande do Norte, Rio Grande do Norte, Brazil, 2Southern Cross University, 3British Antarctic Survey, Cambridge, 4University of California Santa Cruz, Santa Cruz, California, 5University of California Santa Cruz, Santa Cruz, CA, 6Universidad Autonoma de Baja California Sur, La Paz, Baja California Sur, Mexico, 7Universidade de São Paulo, São Paulo, 8Universidade Federal de Santa Catarina, Florianópolis, SC, Brazil, 9Projeto Baleia à Vista, São Sebastião, SP, Brazil, 10Instituto Baleia Jubarte, 11Veleiro Coronado, 12Instituto Baleia Jubarte, Brazil, 13Universidade Federal do Rio Grande do Norte (UFRN), Brazil, Natal, Rio Grande do Norte, Brazil, 14Grand Circle Cruise Line, 15Woods Hole Oceanographic Institute, Woods Hole, MA, 16New York, 17Judith Denkinger, Quito, Pichincha, Ecuador, 18The Polar Citizen Science Collective, 19Panacetacea, Saint Paul, MN, 20National Antarctic Scientific Center / Ukrainian Scientific Center of Ecology of the Sea, Odesa, Ukraine, 21Universidad del Valle, Colombia, Cali, Valle, Colombia, 22Oregon State University, Newport, Oregon, 23National Marine Mammal Laboratory, Seattle, WA, 24Instituto Baleia Jubarte, Caravelas, Bahia, Brazil

Humpback whales (Megaptera novaeangliae) are a cosmopolitan species and perform long annual migrations between low-latitude breeding areas and high-latitude feeding areas. Their breeding populations appear to be spatially and genetically segregated due to long-term, maternally inherited fidelity to natal breeding areas. In the Southern Hemisphere, some humpback whale breeding populations mix in Southern Ocean waters in summer, but very little movement between Pacific and Atlantic waters has been identified to date, suggesting these waters constituted an oceanic boundary between genetically distinct populations. Here, thanks to the improved matching rates and the detection of low-frequency movements by the research collaboration and community science platform “Happywhale”, we present new photo-identification evidence of summer co-occurrence in the West Antarctic Peninsula feeding area of two recovering humpback whale breeding populations from the Atlantic (Brazil) and Pacific (Central and South America). As humpback whale populations recover, growing evidence of these connections (from parasite similarity to cultural exchange) point to the need to revise our perceptions of boundaries between stocks, particularly on high latitude feeding grounds. We
suggest that this “Southern Ocean Exchange” may become more frequent as populations recover from commercial whaling and climate change modifies environmental dynamics and humpback whale prey availability.

**Behavioral Responses of Cuvier’s Beaked Whales to Operational and Simulated Mid-Frequency Active Sonar off Cape Hatteras, North Carolina, USA**

Brandon Southall¹, Andy Read², Doug Nowacek², William Cioffi³, Stacy DeRuiter⁴, Catriona Harris⁵, Heather Foley⁴, Megan McKenna⁶, Nicola Quick⁷, Robert Schick⁸, Jeanne Shearer⁹, Kristin Southall¹⁰, Zachary Swaim¹¹, Len Thomas⁵, Danielle Waples¹¹, Daniel Webster¹², Jillian Wisse¹³


We conducted 11 controlled exposure experiments (CEEs) to examine the response of Cuvier’s beaked whales (*Ziphius cavirostris*) to mid-frequency active sonar signals off Cape Hatteras, NC between 2017 and 2020. Unlike previous studies, which have been conducted on military training ranges, we worked in an area where tactical military sonars are used infrequently. Consequently, whales are likely familiar with, but unlikely habituated to sonar. To measure baseline beaked whale behavior and behavioral responses we deployed 72 satellite-transmitting movement and dive tags and five digital acoustic and movement tags to measure behavior over multiple spatial and temporal scales. In five CEEs we employed operational, full-scale tactical mid-frequency (3-4 kHz) active sonar (MFAS) from U.S. Navy surface vessels. In the remaining six CEEs we used an experimental source to project MFAS waveforms simulating operational systems, but with lower source levels. We used real time in situ sound propagation modeling to estimate received levels (RLs) for focal whales (~120-140 dB re 1 mu Pa) for both operational MFAS and the experimental source. We examined the response of multiple tagged whales during each CEE (max = 12 simultaneous Cuvier’s beaked whales within one CEE), generating comparable RLs for focal whales at variable source-whale ranges. This enabled us to assess the interaction of RL and horizontal range from source for both source types. In more than 80 discrete exposure events we observed strong, short-term behavioral responses, including avoidance, cessation of foraging, and changes in group composition. The strongest responses occurred for both MFAS source types near the upper end of the target RL range, despite large differences in source-whale range. We did not observe broad-scale habitat abandonment and tagged whales typically returned to baseline behavior within a day. We will conduct additional MFAS CEEs during summer 2021.

**Multiparametric Comparative Analysis of Structure and Cellular Composition of Cetacean Brains.**

Kamilla Souza¹, Bruno Mota¹

¹Federal University of Rio de Janeiro, Brazil

Cetaceans (whales, dolphins and porpoises) are exclusively aquatic animals that diverged from their terrestrial relatives approximately 50 million years ago (Fordyce, 2013), evolving significant neuromorphological changes to survive in an aquatic environment. Modern cetaceans include species with the largest and
most folded brains observed to date. It is plausible that the evolution of these and other aspects of brain morphology was influenced by the environment in which they evolved. This work is part of a systematic project to analyze diverse and complementary aspects of cetacean cortical and cerebellar morphology, both intra-specific and inter-specific. We are particularly interested in differences between riverine and maritime species, and between cetaceans and artiodactyls – its sister group -. For this, I have created a collection network for stranded cetacean brains along Brazil's coastline. Currently, we have 31 specimens from 8 species, including animals never anatomically described in the literature.

We use magnetic resonance imaging (MRI) and the isotropic fractionator histological method (Herculano-Houzel, 2005) to study morphology and cellular composition, derive correlations and allometric regularities, and characterize their origins as 1) Physical: universally applicable rules due to underlying physical principles or measurable physical parameters; 2) Convergent: rules arising from similar characteristics and forms towards similar evolutive pressures; and 3) Contingent: Common characteristics due to common ancestry. In this context, we have identified at least one mathematical relationship of type 1 (Mota, 2015). This relationship indicates that the cortical folding process results from a conserved mechanism of physical origin, resulting in a universal scaling relationship empirically verified for a broad range of species. We will investigate whether the gyriification in cetaceans obeys the relationship observed in terrestrial mammals, or if, as we have postulated, it will be affected by the more pronounced hydrostatic pressure that cetaceans are typically submitted in an aquatic environment.

Assessing Management Boundaries of the Common Bottlenose Dolphin *Tursiops truncatus* via Collaborative Photo-Identification

Maureen Spiessl1, Robin Perrtree2, Kim Urian3, Jessica Conway4, Adam Fox4, Antoinette Gorgone5, Aleta A. Hohn7, Alyssa Marian8, Eric Montie9, John Schacke10, Reny Tyson Moore11, Robert Young12, Tara Cox2

1Savannah State University, 2Savannah State University, Savannah, Georgia, 3Duke University Marine Lab, Beaufort, North Carolina, 4NOAA Marine Debris Program, 5University of Georgia, 6University of Miami-CIMAS, NOAA Fisheries Southeast Fisheries Science Center Beaufort, USA, Beaufort, North Carolina, 7NOAA/NMFS/SEFSC, Beaufort, North Carolina, 8University of South Carolina Beaufort, Beaufort, SC, 9University of South Carolina Beaufort, 10Georgia Dolphin Ecology Program, University of Georgia, 11Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, FL, 12Coastal Carolina University, Conway, South Carolina

Management and conservation of the common bottlenose dolphin *Tursiops truncatus* in U.S. waters is challenging due to their complex population structure. In addition, researchers are often limited in time and resources and unable to cover broad geographic areas. Thus, we utilized a collaborative approach to investigate stock structure over a larger area than could feasibly be surveyed by a single research team. We examined the current boundaries of the Northern Georgia/Southern South Carolina Estuarine System (NGSSCES) stock as defined by the National Marine Fisheries Service by comparing photo-identification images from our study area near Savannah, GA (south of Savannah River to northern Ossabaw Sound; n=576) to photo-identification catalogs to the north and south. We compared our catalog to catalogs in the Mid-Atlantic Bottlenose Dolphin Catalog and other regional catalogs, including five catalogs located north of the Savannah River, within the boundaries of the NGSSCES stock, and two catalogs located south of the NGSSCES stock in the adjacent Central Georgia Estuarine System stock. The match rate to the Savannah catalog...
was low, with less than a 10% overlap with each catalog. The percentage of overlap ranged from 3.0% to 6.3% to the north; similarly, the percentage of overlap for the Savannah catalog to catalogs south of the NGSSCES stock boundary was 3.2%. Based on the low degree of overlap, we conclude that the immigration and emigration of the population of dolphins south of the Savannah River and north of Ossabaw Sound is less than births and deaths. Since populations are based on internal dynamics (births/deaths) more than external (immigration/emigration) factors, this study provides evidence of two potential populations within one stock. When genetic analyses cannot discern differences in stock structure and a single research group cannot adequately cover a large area, photo-identification from multiple collaborators can help refine stock boundaries.

Can non-linear phenomena in dolphin (Tursiops) signature whistles be used as vocal biomarkers of health status?
Jessica Sportelli1, Brittany Jones2, Risa Daniels2, Sam Ridgway3


Non-linear phenomena (NLP) in the vocal repertoire of both human and non-human mammals are increasingly recognized as common vocal features. Biphonations, deterministic chaos, sidebands, and subharmonics result from desynchronized oscillating vocal folds, and are commonly associated with communicating urgency, size, and individual recognition. NLP can be audibly ‘rough’ sounding and can be used to diagnose vocal cord pathologies and disease. Although dolphins make sound with vibrating phonic lips rather than vocal cords, their whistles can contain NLP. Stoic animal species, such as Tursiops truncatus often suppress or mask overt behavioral indicators of illness. Individual dolphins at the US Navy Marine Mammal Program are opportunistically recorded during periods of isolation in above ground pools as part of their training. Signature whistle recordings for each dolphin from dates that qualified as a normal or atypical health status were further analyzed for the presence and duration of each NLP type. Results from whistles recorded on healthy dates suggest that NLP are quite common, occurring on average in 47% (range = 24% to 88%) of signature whistles. Here, we present new results on the presence of NLP in the signature whistles of the same focal dolphins on dates of atypical health status. Differences between the presence and duration of NLP in signature whistles between the same animals with differing health statuses will elucidate whether NLP can be used as a vocal biomarker of health in bottlenose dolphins.

Proximity effects of vessel noise on the behavioural responses of whales in the context of whale-watching
Kate Sprogis1, Simone Videsen2, Michael Ladegaard3, Fredrik Christiansen4, Peter Teglberg Madsen

1Marine Bioacoustics Lab, Aarhus University, Australia, 2Aarhus University, 3Department of Biology, Aarhus University, Denmark, Aarhus C, Region Midtjylland, Denmark, 4Aarhus Institute of Advanced Studies, Aarhus, Denmark

In certain areas or situations, whale-watching guidelines approve of vessel approaches at closer distances to cetaceans (e.g. the swim-with-cetacean industry) compared to typical whale-watch distances (e.g. ~100 m). Here, we test the hypothesis that motoring closer to whales even with a quiet vessel will cause greater behavioural responses compared to transiting at a greater distance with a loud vessel, despite the vessel having the same maximum received noise level. To test this, we conducted controlled exposure experiments (n = 33) on humpback whale
(Megaptera novaeangliae) mother-calf pairs on an undisturbed resting ground in northwest Australia. Experiments simulated whale-watch vessel approaches with the same approach type (parallel/tangential) and speed (1.5 knts), with the only variable that differed being the distance/noise level. Three treatment distances and vessel source levels were chosen specifically (32 m/150 dB, 100 m/160 dB, 320 m/170 dB re 1 µPa), to ensure the same maximum received level at the closest point of approach to the whales (120 dB re 1 µPa RMS). With this experimental setup, the relative importance of rate of change in noise level and cumulative noise exposure were examined. Results demonstrated that close vessel approaches had a more abrupt rate of change in noise level and elicited greater behavioural responses of whales compared to vessel approaches at a greater distance with larger cumulative noise exposure levels. We owe this response to the auditory looming effect, where whales were responding to gradually increasing noise levels perceived as a looming potential threat. Previously we suggested the implementation of a whale-watch vessel emission level to keep vessel source levels <150 dB re 1 µPa RMS broadband at 100 m distance and slow speed. Here, we demonstrate that approaches at a close distance to whales cannot be performed without increased disturbance by simply using quieter motorised vessels.

Genetic and acoustic methods have contributed greatly to our knowledge of the distribution and abundance of large whales. While passive acoustic data provides presence information for species over large geographical scales, genetic samples can be used for individual identification, sex determination and assignment to stocks. However, data collection for genetic analysis is often dependent on direct biopsy sampling from a whale, which can be difficult or is not always possible to collect. Environmental DNA (eDNA) sampling offers an option to obtain a genetic sample that does not require close approach or disturbance of the whale. Here, we explore the limits of eDNA for species detection by integrating eDNA sampling in the wake of the whale with passive acoustic recordings within a drifting hydrophone array. Our goal is to estimate an effective detection distance for eDNA sampling. Initial eDNA sampling in the wake of the whale based on focal follows was followed by serial sampling every 15 minutes for up to 2 hours after the passage of the whale within the acoustic array. The location of the whale was determined using acoustic methods and correlated with eDNA results. This work will advance methods in eDNA sampling and will improve interpretation of eDNA results by using a time-series sampling method combined with acoustic tracking of highly migratory whale species in remote waters.

Integrating environmental (e)DNA and acoustic methods for detecting, locating and characterizing genetic diversity of migratory whales

Angela Sremba¹, Robert Dziak², Brian Khan¹, Lauren Roche¹, Haru Matsumoto¹, C. Scott Baker¹, Daniel M. Palacios⁴, Joseph Haxel⁵

¹Cooperative Institute for Marine Resource Studies, Oregon State University, Newport, OR, ²NOAA-PMEL, Newport, OR, ³Marine Mammal Institute, Oregon State University, Newport, OR, ⁴Oregon State University, Newport, Oregon, ⁵PNNL, Sequim, Washington

Power tools for new age marine mammal data science

Mridula Srinivasan¹, Erin McMichael², Christine Stawitz², Patrick Lynch⁴

¹Southeast Fisheries Science Center, NMFS, ²ECS Federal in support of NOAA, ³ECS Federal, Inc in support of NOAA Fisheries, ⁴Office of Science and Technology, NMFS

Across all disciplines, the thrust is on developing statistical and mathematical models to harmonize
and visualize disparate data and address complex problems. This includes marine science research, which is increasingly data-driven. But in a financially constrained environment, there is an added emphasis on leveraging existing datasets from varied ocean observing platforms or animal sensors rather than solely relying on independent and traditional modes of expensive data collection and analyses. Recognizing the need to be nimble and ready to tackle challenging management issues, NOAA Fisheries has invested and facilitated the development of analytical products and applications that are cross-disciplinary and span multiple taxa protected under the Marine Mammal Protection Act and Endangered Species Act. Referred to as the National Protected Species Toolbox (NPST) initiative, the long-term goal is to develop, evaluate, and disseminate a wide range of analytical products and applications to comprehensively assess species within the U.S. Exclusive Economic Zone in support of species conservation and recovery. The NPST initiative began in 2013, and thus far, 19 funded projects have resulted in the development of user-friendly products advancing population assessment methods and model evaluation techniques. Topics covered include estimating species abundance and density, predicting animal movement and species distribution patterns, risk assessments, and analyzing human impacts on vulnerable species. Snapshots of research products are presented to help in the wider dissemination and evaluation of these applications by the broader ecological community. The data are collected from various platforms and instruments, such as manned and unmanned observing systems, telemetry, vessel, aircraft, or shore-based platforms, and passive acoustic recorders. Products are housed in a Fisheries Integrated Toolbox GitHub repository, which is a centralized platform to share NOAA Fisheries’ fish, ecosystem, human dimensions, and protected species-focused toolboxes. These research investments reinforce the importance of supporting curiosity-driven science that will result in creative conservation solutions.

**Abundance Indices of Beluga (Delphinapterus leucas) Populations in James Bay and Eastern Hudson Bay from 1985 to 2021**

Anne P. St-Pierre¹, Jean-François Gosselin², Arnaud Mosnier³, Mike Hammill⁴

¹Fisheries and Oceans Canada, Rimouski, ²Fisheries and Oceans Canada, Mont-Joli, Québec, ³Fisheries and Oceans Canada, Mont-Joli, ⁴Department of Fisheries & Oceans Canada, Rimouski, Quebec

Large scale aerial surveys are used to estimate abundance of many cetacean species. The probability of detecting animals during these surveys is subjected to two potential biases: 1) availability bias, when animals are present in the area but not visible to the observer while diving, and 2) perception bias, when animals are at the surface but are missed by the observer. In northern Quebec (Canada), large scale surveys are flown to estimate the abundance of beluga as part of a framework to provide management advice. Previous beluga population estimates from 7 surveys flown between 1985 and 2015 only included a correction for availability bias developed for St. Lawrence Estuary beluga, but no correction for perception bias. However, the 2015 aerial survey was flown using a double-platform configuration in which a pair of independent observers searched the same visual area to detect belugas, allowing perception bias to be estimated using mark-recapture distance-sampling models. Sightings recorded with a difference in time abeam of <10s and a difference in inclination angle of <10° among observers were considered as a duplicate pair, i.e., sighted by both observers. Overall, 22% of belugas were sighted by both observers, yielding a perception bias correction factor ($p(0)$) of $0.399 \pm 0.077$. Adjusting for both perception and availability biases produced estimates ~5.3 times higher than the uncorrected estimates. Applying both corrections to the 7 survey estimates in the
time series, the overall abundance trends remain, but with greater variations among years and wider confidence intervals. A new survey planned for 2021 will be flown using the double-platform approach and will provide insights into the stability of our perception bias estimates. These results emphasize the need to consider availability and perception corrections to obtain robust abundance estimates and could have implications for management of beluga in northern Quebec.

The behavioural impacts of commercial swimming with whale tours on humpback whales in Hervey Bay, Australia. Stephanie Stack¹, Kate Sprogis², Grace Olson³, Florence Sullivan¹, Abigail Machernis³, Jens Currie¹
¹Pacific Whale Foundation, ²Marine Bioacoustics Lab, Aarhus University, Australia, ³Pacific Whale Foundation, Wailuku, HI

Swim-with-whale tourism has expanded across several countries globally, with humpback whales (Megaptera novaeangliae) being the most commonly targeted species of baleen whale. Behavioural responses from humpback whales to swim-with-whale tours have been reported, however, responses are likely population and region-specific for this cosmopolitan species. In 2014, swimming with humpback whales began in Hervey Bay, which is an important resting ground/migratory stopover for humpback whales and, in 2017, it became a permanent fixture as a tourism enterprise. The behavioural responses of humpback whales to this swim-with-whale industry have not been examined, preventing informed mitigation measures from being added to the voluntary Code of Conduct developed by local tour operators. Thus, the aims of this study were to 1) examine short-term behavioural responses in whales before, during and after swim-with tours, and 2) investigate the behavioural responses of whales throughout swim-with-whale tours compared to whale watch tours. Data were collected on board a tour vessel, where opportunistic before, during and after data were collected during swim-with-whale tours (250 hrs) and whale watch tours (150 hrs). During swim-with-whale tours, the number of direction changes was highest when swimmers were in the water and this decreased after the vessel and swimmers left the area. Whales spent 43% less time resting during swim-with-whale tours when compared to whale watch tours. Regardless of tour type, the time spent engaging in surface active behaviours was impacted by distance between the vessel and the whale(s). These results support the conclusion that the natural behaviour of humpback whales in Hervey Bay was altered in response to swim-with-whale tourism. In Australia, where swim-with-whale tourism is already established, robust education and enforcement programs, combined with continued monitoring of population dynamics through scientific research, are needed to minimize detrimental impacts to the population and guide adaptive management strategies.

Changes in the acoustic activity of beaked whales and sperm whales recorded during a naval training exercise off eastern Canada Joy Stanistreet¹, Wilfried A. M. Beslin², Katie Kowarski³, Bruce Martin⁴, Annabel Westell⁵, Hilary Moors-Murphy⁶
¹Fisheries and Oceans Canada, ²Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, ³JASCO Applied Sciences, ⁴JASCO Applied Sciences, Dartmouth, NS, ⁵NEFSC, NMFS, NOAA/Integrated Statistics, Kingsburg, Nova Scotia, ⁶Fisheries and Oceans Canada, Dartmouth, Nova Scotia

Mid-frequency active sonar (MFAS) used in naval anti-submarine warfare training has been linked to mass strandings of beaked whales and other cetaceans, and experimental research has demonstrated that beaked whales exhibit strong...
avoidance reactions to MFAS, including the cessation of echolocation and foraging activity. Much of this research has occurred on or near naval training ranges off the U.S. coasts, and impacts from real-world naval exercises in other offshore regions remain poorly understood. In September 2016, a large-scale multinational naval exercise, ‘CUTLASS FURY 2016’ (CF16), was conducted off eastern Canada. MFAS signals from the CF16 exercise were recorded by a concurrent passive acoustic monitoring project underway in the region. We used these recordings to quantify the occurrence and characteristics of MFAS signals, measure ambient noise levels, and assess changes in the acoustic activity of beaked whales and sperm whales. Echolocation clicks from Cuvier’s beaked whales (CBW) and sperm whales (SW) were commonly detected (77% and 87% of recording days, respectively), while unidentified Mesoplodont beaked whale (UMBW) clicks were detected more sporadically (46% days). Using generalized linear models with pairwise Tukey contrasts, we compared the number of hours per day with click presence of each species in 8-day periods before, during, and after CF16 as well as the same periods in control data from the prior year. Click presence for CBW and SW was significantly reduced during CF16 compared to the pre-exercise period and the control year, with periods of click absence lasting several days. UMBW clicks were entirely absent from the recordings during CF16 and for seven days afterward. These results suggest that beaked and sperm whales ceased foraging in the vicinity of the CF16 exercise while MFAS was deployed and were likely displaced from the affected area. Such disturbance may have energetic, health, and fitness consequences for these species.

\textbf{Findings from Sowerby’s beaked whale (Mesoplodon bidens) strandings in Sweden 2015-2020}  
\textbf{Jasmine Stavenow}¹, Anna Roos², Erik Ågren³, Aleksija Neimanis⁴

On three separate occasions between 2015-2020, five Sowerby’s beaked whales (Mesoplodon bidens, SBW) stranded in Sweden. Prior to 2015, SBW strandings in Sweden were exceptionally rare events occurring many decades apart. Four of the animals were fully necropsied including extensive sample and data collection according to standardized protocols, and the fifth was sampled in field. We summarize the stranding events, biological and pathological findings here. Stranding events occurred in October 2015 (n=1), August 2019 (n=3) and July 2020 (n=1), on the southern and western coasts of Sweden. All SBW were immature, four were males and one female, and their lengths ranged between 3.42 and 4.55 m. Cause of death for the single stranded animals were emaciation (n=1) based on history and severe epaxial muscle atrophy, and euthanasia due to traumatic injuries (n=1). Cause of death for the mass stranding of three subadult males could not be determined. They stranded alive but died shortly after refloating. They were not emaciated and infectious diseases including brucellosis, morbillivirus and avian influenza were ruled out. Computer tomography of the heads of two of these animals was performed to exclude sonar-related stranding, but advanced decomposition precluded interpretation. Other findings included pox-like dermatitis, and traumatic injuries. Two of the animals involved in the mass stranding had older skeletal lesions consistent with previous osteomyelitis. Stomach contents were analysed for dietary items using macroscopic analyses on hard parts as well as eDNA analysis. Our findings provide more knowledge about an elusive species, and support previous discussions that juveniles, often between July – October, are prone to strand. The reason for the increase in number of strandings in Sweden during recent years remains unknown.
but may potentially indicate changes in population distributions, or possibly reflect new threats, so continued surveillance is warranted.

**Micro-Scale Spatial Patterns in Harbour Porpoise Acoustic Activity**

**Johanna Stedt¹**, Per Carlsson¹, Magnus Wahlberg², Julia Carlström¹, Anders Nilsson¹, Mats Amundin³, Erland Lettevall³, Nikolay Oskolkov⁴

¹Lund University, Sweden, ²Marine Biological Research Centre, University of Southern Denmark, Kerteminde, Funen, Denmark, ³Swedish Museum of Natural History, Stockholm, Sweden, ⁴Kolmården Djurpark, Kolmården, Sweden, ⁵Swedish Agency for Marine and Water Management, Sweden

Habitat heterogeneity is a crucial driver for species distribution across scales. Harbour porpoise *Phocoena phocoena* basin-wide distribution is linked to prey availability, and small-scale (kilometers to tens of kilometers) differences in distribution are prevalent. However, information on porpoise distribution and foraging-behaviour variations on a micro-scale (hundred meters to kilometers) is limited. To monitor harbour porpoise distribution and foraging activity on a micro-scale we deployed passive acoustic dataloggers, logging porpoise acoustic activity at six sites in a small, high porpoise-density area. Data were collected for almost a year, giving detailed time series on porpoise activity. The time series were analyzed using dynamic time warping to compare activity patterns between sites. Large differences were found between sites separated by only a few hundred meters, indicating micro-scale spatial preference. Spatial patterns were linked to foraging intensity (feeding buzzes), showing a positive correlation between porpoise presence and foraging activity. The study demonstrates that harbour porpoise spatial distribution on micro-scale should be considered in e.g. behavioural, management and conservation studies and actions.

**Whale Sightings Data via Whale Alert and Spotter Pro as a Near Real-Time Data Input for the Assessment of Whale Activity in Southern California**

**Callie Steffen¹**, Sean Hastings², Virgil Zetterlind³, Shauna Bingham³

¹Benioff Ocean Initiative, Goleta, CA, ²Channel Islands National Marine Sanctuary, Santa Barbara, ³ProtectedSeas, Fort Walton Beach, FL

Whale-ship collisions are one of the leading causes of death for great whales worldwide, oftentimes going undetected. Near real-time data streams can provide situational awareness for mariners to assist in data-driven decision making while transiting in important whale habitat. Whale Safe is an online tool that integrates a dynamic blue whale habitat model, acoustic detections, and whale sightings data from the Whale Alert and Spotter Pro applications by trusted observers and trained members of the Channel Islands Naturalist Corps. This is the first time these three complementary data sources have been combined to assess whale presence, serving as California’s first automated whale notification system. The platform displays a “Whale Presence Rating” (WPR) that ranges from low to very high and communicates an easy interpretation of whale activity in the Santa Barbara Channel. In addition to being a near real-time data input, the historical data recorded using the applications contributed to establishing species specific sighting thresholds for each rating level in the WPR. The Whale Safe platform can be considered “modular “and could be replicated in other regions based on specific data needs including whale sightings, demonstrating the reach and value offered by the technology-powered applications. Long-term data, collected by citizen scientists with Channel Islands National Marine Sanctuary, also supported the management decision of shifting the International Maritime Organization (IMO)
designated shipping lanes by providing empirical evidence that the lanes spatially overlap with important feeding grounds for endangered blue, fin, and humpback whales. The Conserve IO platform allows a wide-ranging group of stakeholders to connect and work towards the common goal of whale conservation.

Population structure and genetic connectivity reveals distinctiveness of Irish harbour seals (Phoca vitulina) and implications for conservation management
Kristina Steinmetz1, Sinead Murphy2, Oliver Ó Cadhla1, Emma Carroll1, Aubrie Onoufriou1, Debbie JF Russell6, Michelle Cronin7, Luca Mirimin2
1Atlantic Technological University, Ireland, 2Galway-Mayo Institute of Technology, Galway, Ireland, 3Department of Housing, Planning and Local Government, Cork, Ireland, 4University of Auckland, Auckland, New Zealand, 5Scottish Oceans Institute, 6SEA MAMMAL RESEARCH UNIT, UNIVERSITY OF ST ANDREWS, ST ANDREWS, United Kingdom, 7University College Cork, Cork

1. The identification of discrete intraspecific units, such as genetically informed Management Units (MUs), is important to effectively develop and implement conservation strategies for protected species. Harbour seals (Phoca vitulina) occurring in Irish waters are currently viewed as a single nationwide panmictic population (and hence MU), though this assumption is not based on knowledge of population structure, due to a lack of available genetic data.

2. Thus, the present study used mitochondrial control region sequences and 9-11 microsatellite loci from harbour seals from Ireland and Northern Ireland (up to n = 123) and adjacent UK/European waters (up to n = 289) to provide insights into the genetic population structure and diversity of harbour seals in the studied areas.

3. Within the island of Ireland, genetic analyses revealed the presence of three genetically distinct putative populations characterised by high genetic diversity, hereby defined as: Northwestern and Northern Ireland (NWNI), Southwestern Ireland (SWI) and Eastern Ireland (EI).

4. Using previously published and newly generated data, a subsequent wider scale analysis revealed that the Irish SWI and EI putative populations were genetically distinct from neighbouring UK/European areas, whereas seals from the NWNI area could not be distinguished from a previously identified northern UK metapopulation. Migration rate estimates showed that NWNI receives migrants from Northwest Scotland, with NWNI acting as a genetic source for both SWI and EI.

5. The present study provides the most comprehensive genetic assessment of harbour seals in European waters to date, with findings indicating that conservation strategies for harbour seals in Irish waters should be amended to accommodate at least three genetically distinct putative populations/MUs. The use of interdisciplinary approaches considering ecological as well as genetic parameters is recommended for future assessments and delineation of units of ecological relevance for conservation management purposes.

California sea lions (Zalophus californianus) are impacted by vessel disturbance in newly established Whale Heritage Site of Dana Point, California.
Lei Lani Stelle1, Jordan Buttner2
1University of Redlands, Redlands, California, 2University of Redlands, Redlands, CA
Marine ecotourism is growing worldwide and Dana Point, California was recently recognized as the first Whale Heritage Site in the United States. The area attracts nearly 2 million tourists each year and the harbor holds 2500 boats. California sea lions (Zalophus californianus) are commonly observed, yet little is known regarding the impacts of vessel traffic. A population of California sea lions that rest on a buoy outside Dana Point Harbor were observed from an elevated shore-based observation point using a spotting scope. Behavioral states and transitions were recorded during focal observations, along with details on all vessels passing within the field of view. Markov chain analysis was used to determine probabilistic differences in the observed behavioral transitions under control and impact conditions. Initial stochastic evaluations were compared using both a Monte Carlo simulation and a multinomial logistic regression. Data collected from 22 observation periods with 2000 behavioral transitions (1519 control and 481 impact) revealed that rest was the dominant activity state overall (68%). A total of 268 boats passed near the buoy: the majority were speedboats (41%) followed by sailboats (29%) and only 6% were dedicated whale watch boats; vessels were in close proximity to the buoy for an average of 13.7 seconds (range 1-138 sec). Sea lions exposed to vessel traffic exhibited a significant decrease in rest behaviors from 86% to 72%, with an increase in transitions to alert from 8.9% to 18% and transitions to active from 4.9% to 10% (p<0.05). Although this population of sea lions is stable, they are impacted by ENSO events so reductions in time spent at rest could push them past their energetic thresholds exacerbating periods of nutritional stress. Outreach education to local boaters sharing these findings and recommended guidelines for observing the animals could help to reduce disturbance.

Body condition and age-specific habitat use of humpback whales in the New York Bight: Implications for vulnerability to anthropogenic threats

Julia Stepanuk1, Nathan Hirtle1, Eleanor Heywood2, Lesley Thorne3
1 Stony Brook University, 2 SUNY Stony Brook, 3 Stony Brook University, Southampton, New York

Humpback whales (Megaptera novaeangliae) are impacted by both lethal and sublethal anthropogenic threats. An ongoing Unusual Mortality Event along the eastern seaboard of the U.S. is predominately comprised of juvenile humpback whales. In the New York Bight, juveniles have been observed lunge feeding close to shore, but it is unclear whether the habitat use and foraging behavior of juveniles might influence their vulnerability to vessel strike. In addition, sublethal stressors in this highly urbanized environment could impact long-term population trends, and metrics of body condition can be used to inform population health. We compare the habitat use and foraging behavior of juvenile and adult humpback whales in the NYB, model variability in body condition, and examine implications for vulnerability to anthropogenic threats. We conducted boat-based surveys in the NYB from 2018-2021 and conducted focal follows to identify individual whales, document foraging behavior, and obtain morphometric measurements using an Unoccupied Aerial Vehicle. We determined animal lengths and age class from morphometric data and derived body volume from a 3D humpback whale model. Whales foraging in nearshore waters were exclusively surface feeding juveniles, while both juveniles and adults foraged cooperatively in offshore waters. We found age-based, as well as inter- and intra-seasonal variability in modeled body volume. Nearshore habitat use and surface foraging behavior may make juveniles particularly vulnerable to vessel strikes in nearshore waters and analyses of AIS data suggest that passenger vessels in these waters may be a risk factor. Our seasonal and age-based
body volume models will allow future body condition studies to account for age and day of year in order to make comparisons between regions and time periods. This work highlights the importance of understanding age-specific differences in habitat use and of using metrics of body condition to better understand anthropogenic threats to large whales.

Marine mammals in Peru with cookie-cutter shark bites (Isistius brasiliensis): First record of interspecific interactions.
Claire Stepchew¹, Carlos Francisco Yaipen-Llanos²

¹Organization for Research and Conservation of Aquatic Animals - ORCA PERU, ²Organization for Research and Conservation of Aquatic Animals - ORCA PERU, Surco, Lima, Lima, Peru

Interactions between marine mammals and the predatory cookie-cutter shark (Isistius brasiliensis) on the Eastern South Pacific coast are poorly documented. I. brasiliensis have a worldwide range that spans throughout the costal warm equatorial waters and are known to be an opportunistic feeder on large pelagic organisms such as marine mammals. ORCA Stranding Network in Peru has recorded shark predation interactions (N=179) in stranded specimens over the past 20 years. Here, we describe the occurrence of I. brasiliensis predation bite marks found on five species of coastal marine mammals: Tursiops truncatus, Phocoena spinipinnis, Lagenorhynchus obscurus, Lontra felina and Otaria byronia. For every stranded mammal, we recorded gender, biometrics, physical description, geo-location and lesion description. Lesions compatible with cookie-cutter bite range from 8 to 18cm in diameter with the typical concave circular “cookie” shape compromising skin and muscular tissue on hips, abdomen, flipper and neck. 32% of the interactions were found in dead specimens. All cetaceans and marine otter with lesions were found dead and share similar characterization and anatomical location of the lesion. Only South American sea-lions (O. byronia) were alive, rescued and placed in rehabilitation. Lethality reached 31.25% (n=16) accounts of recorded O. byronia with the presence of I. brasiliensis predation wounds. Our findings conclude that there was no distinct age group to be affected more than others, as our results range from weanlings to adults, and only one newborn sea-lion was recorded dead. A third of the interactions between marine mammals and cookie-cutter sharks were male while the rest occurred on females. The survival rate for O.byronia cookie-cutter encounters was 62.5%. These observations are significant to understand how these species interact with one another as the frequency of their occurrence reveal a new predatory threat. This is the first report of cookie-cutter shark bites on marine mammals in Peru.

Common bottlenose dolphin (Tursiops truncatus) sound production rates: variations with group size and the presence of young
Jared Stephens¹, Shannon Gowans², Erin Frick³, Peter Simard⁴

¹Eckerd College, Palmdale, California, ²Eckerd College, St Petersburg, FL, ³Eckerd College, Amazon River Dolphin Conservation Foundation, St. Petersburg, Florida, ⁴Eckerd College, St. Petersburg, FL

Like all odontocete cetaceans studied, common bottlenose dolphins (Tursiops truncatus) use acoustic signals for echolocation and social purposes. Acoustic behavior can change with naturally occurring variations in factors outside (e.g., presence of predators) and inside (e.g., group composition) the group. The goal of this study was to investigate the effects of the presence of calves, juveniles, and changes in group size on sound production rates of free-ranging bottlenose dolphins. Acoustic files were recorded during boat-based group follows in Tampa Bay, Florida, between 2009 and 2019.
For each group, the group size and the number of calves and juveniles were recorded in the field. Dolphin sounds (echolocation click trains, whistles, and burst pulses) were manually identified using Raven Pro 1.5 spectrogram software. Dolphin sounds were quantified in the first 15 minutes of each acoustic recording with high signal-to-noise ratio to maximize sound detection and standardize recording length. For each sound type, a generalized linear model was used to analyze the differences in sound production rate in relation to group size and the number of calves and juveniles relative to group size. Preliminary analysis of 13 dolphin groups indicated significant relationships between echolocation rates and group size and the proportion of juveniles present, as well as between burst pulse rates with the proportion of calves present. This study contributes to our overall knowledge of the acoustic behavior of bottlenose dolphins in relation to social factors. Additionally, this study increases our understanding of the relationships between sound detections and group size and group composition which will improve our abilities to use autonomous acoustic recordings to calculate density and population estimates.

Decreasing body lengths are a troubling trend in North Atlantic right whales

Joshua Stewart1, John Durban2, Amy Knowlton3, Holly Fearnbach4, Wayne Perryman5, Morgan Lynn6, Jacob Barbaro7, Carolyn Miller7, Michael J Moore7

1NOAA SWFSC Marine Mammal & Turtle Division, San Diego, 2Oregon State University, 3Anderson Cabot Center for Ocean Life at the New England Aquarium, Boston, MA, 4SR3, SeaLife Response, Rehabilitation and Research, Seattle, WA, 5NOAA Southwest Fisheries Science Center, 6National Oceanic and Atmospheric Administration, Southwest Fisheries Science Center, La Jolla, California, 7Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

Whales are now largely protected from direct harvest, leading to partial recoveries in many previously depleted species. However, most populations remain far below their historical abundances and incidental human impacts, especially vessel strikes and entanglement in fishing gear, are increasingly recognized as key threats. In addition, climate-driven changes to prey dynamics are impacting the seasonal foraging grounds of many baleen whales. In many cases these impacts result directly in mortality. But it is less clear how widespread and increasing sub-lethal impacts are affecting life history, individual fitness, and population viability. North Atlantic right whales (NARW) have been monitored consistently since the 1980s and have been declining in abundance since 2011 due primarily to deaths associated with entanglements in active fishing gear and vessel strikes. High rates of sub-lethal injuries and individual-level information on age, size and observed entanglements make this an ideal population to evaluate the effects that these widespread stressors may have on individual fitness. We evaluated changes in body lengths of NARW using aerial photogrammetry measurements collected from crewed aircraft and remotely operated drones between 2000 and 2019. We find that entanglements in fishing gear are associated with shorter whales, and that body lengths have been decreasing since 1981. In addition, we show that several metrics of reproductive output in female NARW are correlated with body length, demonstrating the potential effects of decreasing body lengths on population viability. Along with reduced reproductive output, smaller body sizes may lead to increased probability of lethal gear entanglements. Our findings show that sub-lethal stressors threaten the recoveries of vulnerable whale populations even in the absence of direct harvest.
First Assessment of Microplastics in a New Zealand Marine Mammal Species

Karen Stockin¹, Olga Pantos², Emma Betty³, Fraser Doak³, Hayden Masterton³, Gabriel Machovsky⁵
¹Massey University, Auckland, New Zealand, ²ESR New Zealand, ³Massey University & Auckland University of Technology, Auckland, New Zealand, ⁴ESR New Zealand, New Zealand, ⁵Massey University, New Zealand

Plastic pollution is known to affect marine mammals in a variety of manners. One area of specific concern is exposure to microplastics (MPs). These small (<5 mm), pervasive and persistent synthetic particles are bioavailable to marine organisms, via direct ingestion and/or trophic transfer. While of concern, the impact on marine mammals is relatively understudied compared to other taxa. To date, the presence of MPs in New Zealand marine mammals has not been studied. Here we provide a first assessment of MPs in sixteen common dolphins (Delphis delphis) which single and mass stranded along the New Zealand coast between 2019 and 2020. Stomach contents were examined under strict laboratory contamination-controlled conditions. All potential MPs were analysed using Fourier transform infrared spectroscopy. MPs were ubiquitous, with particles detected in every animal examined. Contrary to most prior MPs studies on marine mammals, the majority of polymers detected here represented fragments (77%, n=90) as opposed to fibres (23%, n=27), with size ranging from 44-4,361 µm (mean=584, SE=98) and 198-10,032 µm (mean=1,567, SE=324), respectively. Six colour categories were identified, with clear (46%), black (10%), orange (10%) and multicoloured (10%), most prevalent. Polymer type varied between fragments and fibres, with polypropylene (PP, 31%), acrylonitrile butadiene styrene (ABS, 20%) and polyethylene (PE,14%) most recorded in fragments, while polyethylene terephthalate (PET, 65%) and PP (13%) were most prevalent in recovered fragments. Translucent PP and PET are commonly used for medicine containers, bottle caps and beverage packaging, respectively. ABS is a rigid thermoplastic used in a large range of applications from cars to toys, while PET (in the form of polyester) is frequently used in textiles, including approximately half the world’s clothing. Considering MPs are increasingly being shown to have a wide range of deleterious effects across taxa, these findings in a sentinel marine species are of concern.

Phylogenetic insight to the first case of pestivirus detected in a Baltic harbour porpoise

Iben Stokholm¹, Nicole Fischer², Morten Tange Olsen², Anders Galatius³, Christine Bächlein⁴, Alexander Postel⁴, Ursula Siebert⁴, Paul Becher⁴
¹PhD student, Copenhagen, Copenhagen, Denmark, ²Institute for Medical Microbiology, Virology and Hygiene, Hamburg, Germany, ³Aarhus University, Department of Bioscience, Roskilde, Denmark, ⁴Institute of Virology, Department of Infectious Diseases, University of Veterinary Medicine Hannover, Hannover, Germany, ⁵Institute for Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Buesum, Schleswig-Holstein, Germany

During the past century the harbour porpoise (Phocoena phocoena) populations of the Baltic Sea have experienced serious declines due to whaling, ice winters, bycatch, prey depletion, chemical and noise pollution. However, little is known about viral diseases in Baltic harbour porpoises which could be adding further pressure on the population health. Recently a novel pestivirus named Phocoena pestivirus (PhoPeV) was described in harbour porpoises from the North Sea thereby expanding the host range from the terrestrial to the marine environment. So far, the role of this virus as a disease-causing agent is not known but intrauterine infections with the closely related porcine pestiviruses Bungowannah virus and Linda virus can cause...
increased rates of abortions as well as myocarditis, congenital tremor and death in young piglets. Here we investigate the presence of the virus in 77 harbour porpoises collected in the outer and inner waters of the Baltic Sea between 2007-2019. A pestivirus was detected by RT-qPCR in one juvenile female collected as a bycatch along the coast of Zealand, Denmark in the winter of 2011. The full genome was sequenced, and comparative sequence analyses including Bayesian phylogenetic analyses were conducted based on complete coding sequences and partial genomic sequences. Our analyses revealed a close relationship to pestiviral sequences obtained from harbour porpoises of the North Sea with a recent divergence from the most closely related sequences (Genotype 1) in 2004. Additional analyses are underway and will elucidate the pathological impacts on a population level.

Foreign body ingestion for cetaceans from the central east coast of Florida, United States (2000-2019).
Megan Stolen1, April Geer2, Wendy Nokene-Durden1, Teresa Jablonski2
1Blue World Res. Inst., Melbourne Beach, FL, 2Hubbs-SeaWorld Research Inst, Melbourne Beach, FL, 3Hubbs-Sea World Research Institute, Melbourne Beach, FL

Floating oceanic debris has received considerable attention as some types resemble marine invertebrates that are prey for sea turtles and marine mammals however, fewer records have been published for nearshore systems resulting from unusual or household debris items. The Indian River Lagoon (IRL) is a shallow water estuary located on the east coast of Florida and is home to a resident population of bottlenose dolphins (Tursiops truncatus). Separated from the Atlantic Ocean by barrier islands, the IRL is a hotspot for entanglement and ingestion of fishing gear which has been reported in previous studies. In this investigation, we determined the prevalence of foreign body ingestion in cetaceans for a portion of east Florida and conducted a comparison between the estuarine and oceanic animals. From 2000-2019, there were 1205 stranded cetaceans reported of which 771 received postmortem gastrointestinal (GI) examinations at necropsy. Recreational fishing gear was excluded, leaving 23 cases of foreign body ingestion made from plastic and non-plastic materials. Sixteen cases involved bottlenose dolphins and of those, all were found in the IRL. There were seven cases along the corresponding Atlantic beach: five Kogia whales, one humpback whale (M. novaeangliae) and one short-finned pilot whale (G. macrorhynchus). The male to female ratio was fourteen to seven with two animals being of undetermined sex. The majority of cases (19) were adult animals. Overall, the positive cases represented three percent of all the post-mortem GI exams and only four were positively associated with GI pathology. While ingestion of plastic and unusual debris items in IRL dolphins should be carefully monitored, it does not appear that this is a significant source of mortality for the local population. Conservation efforts and public messaging should be focused on recreational gear entanglement and ingestion which is a significant source of injury and mortality.

Assessing the Feasibility of Citizen Science to Monitor Cetacean Distribution and Change in Iceland
Alyssa Stoller1, Thomas Grove2, Ívar Örn Hauksson2, Lea-Anne Henry2, Aidan Keane1
1Whale Wise, Bellingham, Washington, 2University of Edinburgh, Edinburgh, United Kingdom, 3University of Edinburgh, United Kingdom

Cetaceans have been a prevalent part of Icelandic culture dating back to the 10th century. As both a whaling nation, and home to a thriving whale watching industry, Iceland is known for its
complex relationship with cetaceans. Cetaceans have been routinely studied in Iceland for the past 30 years, however, there are still gaps in understanding their current and changing distributions. Furthermore, widespread surveillance of cetaceans is an expensive and laborious process, and often conducted seasonally. This study examines the feasibility of using citizen science in Iceland to monitor change and cetacean distribution. Citizen science is a relatively cheap and effective tool for collecting data, educating participants and sparking community-ownership, but its success depends on willingness of participants to contribute data. We surveyed individuals’ interest to contribute and knowledge of cetaceans through an online questionnaire. We targeted fishers and whale watching employees as two groups who spend considerable time at sea, covering large areas. Our prior expectation was that whale watching employees would be more willing to contribute to cetacean citizen science. In total, 81 fishers and 30 residents and workers took the questionnaire. Although just under 50% of participants were interested in submitting cetacean sightings in the future, the projected survey coverage was still widespread across Iceland with 52 individuals. Participants were also tested in their ability to identify species – fishers often were unable to recognize cetacean species by image. However, fishers were able to identify species specific changes they had observed over time and cetacean prey associations. These comments correspond well with current scientific understanding and therefore add to the credibility of participants. Based on the results of this study, a citizen science project in Iceland is possible and likely will support a better understanding of Icelandic cetaceans.

Differences Beyond Diving Bradycardia
Between the Hearts of Marine and Terrestrial Mammals
Rhea L. Storlund¹, David Rosen², Andrew W. Trites²
¹UBC Marine Mammal Research Unit, Vancouver, ²UBC Marine Mammal Research Unit, Vancouver, British Columbia

Many studies have characterized the ability of marine mammals to significantly lower their heart rates when diving. However, little work has been done to investigate whether the hearts of marine mammals function fundamentally differently from terrestrial mammals. Our study investigated differences in cardiac timing between marine and terrestrial mammals. We analyzed electrocardiogram (ECG) parameters from 50 species of terrestrial mammals and 19 species of marine mammals to determine whether the electrical activity of the heart differs between these two groups, how it scales to body mass, and whether it is affected by physiological state (i.e., anaesthetized or conscious). Heart rates and PR intervals scaled the same for all mammals, but marine mammals had 19% longer P-waves, 24% longer QRS intervals, and 21% shorter QT intervals. In other words, marine mammals had slower atrial and ventricular depolarization, and faster ventricular repolarization than terrestrial mammals. Physiological state did not affect ECG parameters, and therefore was not a source of these differences. On average, ECG interval durations scaled with body mass to the power of 0.21 (range: 0.19–0.23) rather than the expected 0.25—while heart rate scaled with body mass to the power of -0.22, and was greater than the widely accepted -0.25 derived from fractal geometry. Our findings show clear differences between the hearts of terrestrial and marine mammals in terms of cardiac timing that extend beyond diving bradycardia. They also highlight the importance of considering special adaptations (such as breath-hold diving) when analyzing allometric relationships.
Multiple habitat-dependent dive characteristics revealed in Eastern Beaufort Sea beluga whales tracked over an annual cycle

Luke Storrie¹, Lisa Loseto², Greg O’Corry-Crowe³, John Iacozza¹, David Barber¹, Alex Nunes⁴, Nigel Hussey⁵, Shannon MacPhee⁶
¹University of Manitoba, Winnipeg, Manitoba, ²Fisheries and Oceans Canada/Freshwater Institute, Winnipeg, Manitoba, ³Florida Atlantic University, ⁴Ocean Tracking Network, ⁵University of Windsor, ⁶Fisheries and Oceans Canada, Winnipeg

Beluga whale (Delphinapterus leucas) dive behaviour represents multiple ecological functions, however, our understanding of dive characteristics is limited by the resolution or longevity of tagging studies. Knowledge on the time-depth structures of dives can provide insight into the behaviours represented by vertical movements, the ecological importance of habitats occupied, and the energetic consequences of targeting various prey at a given depth. Satellite-linked time-depth-recorders were attached to 13 male belugas from the Eastern Beaufort Sea population, and depths were transmitted as time-series sampled at a 75 s frequency across all months between July 2018 and November 2019. A new Python package, divebomb, was used to identify and characterise 90,211 dives by time and depth metrics, and these were classified into eight dive types using a mixed classification procedure involving Gaussian mixed modeling and hierarchical clustering analyses. Frequency of dive types was compared amongst regions and seasons. Dive structures suggest a number of strategies used to support year-round foraging by this population. Shallower and more frequent benthic diving during winter in the Bering Sea indicate foraging may be energetically cheaper but less rewarding than deeper benthic diving during summer in the Beaufort Sea and Arctic Archipelago. The onset of the day/night cycle during fall coincided with belugas entering the deep waters of the Arctic Basin, and they made pelagic dives targeting deeper layers during the day and shallower layers during the night. Dive functions are proposed based on their time-depth structures, optimal foraging theory, physiology, and other life history traits. This study provides baseline information on the year-round dive behaviour of Eastern Beaufort Sea belugas, which is critical in monitoring how this population may respond to environmental change.

Elemental concentrations and persistent organic pollutants in the endangered Hawaiian monk seal and select prey species from the Northwest Hawaiian Islands

Yvanna Strait¹, Dimitrios Giarikos², Charles Littnan³, Amy C. Hirons⁴
¹Nova Southeastern University, ²Nova Southeastern University, Ft. Lauderdale, ³Society for Marine Mammalogy, Honolulu, Hawaii, ⁴Nova Southeastern University, Dania Beach, FL

The endangered Hawaiian monk seal (HMS), endemic to the Northwest Hawaiian Islands (NWHI), is slowly becoming established within the Main Hawaiian Islands, which may place the seals in areas of higher anthropogenic (urban industrialization, agricultural practices, and military activity) and natural (volcanic activity) sources of trace elemental contaminants (heavy metals) and persistent organic pollutants (POP) compared to the NWHI. HMS bone, which represents up to 10 years of a seal’s life, was opportunistically collected from skeletons of naturally deceased seals from the NWHI as were whole dominant fish prey species from the southern NWHI. Preliminary data from 6 NWHI females from early 2000s show Zn (108 – 203 µg/g) yielded the highest concentrations followed by Cu (0.73 – 3.3 µg/g), Cr (0.97 – 6.3 µg/g), and Pb (0.75 – 4.8 µg/g), and no detectable Ni. Preliminary data from 8 fish species show Cr (67.8 – 462 µg/g) and Zn (150 – 501 µg/g) yielded the highest concentrations followed by Cu (23.1 – 144 µg/g) and Ni (13.6 – 28.8 µg/g),
and no detectable Pb. Lead (Pb) is the only nonessential element tested in the preliminary study and the only element to show an order of magnitude higher concentration than potential prey. Five samples each of bone and homogenized prey were analyzed for polychlorinated biphenyls (PCB); it yielded total PCB concentration 4280 ng/g – 10400 ng/g in seal bone, similar to or slightly less than an order higher than previously reported values in HMS blubber and serum. Whole prey contained total PCBs of 5830 – 16500 ng/g. Further analyses of more trace elements as well as specific herbicides/insecticides (PCB), flame retardants (PBDE), and petroleum products (PAH) are ensuing. By studying the spatial distribution of the seals relative to crustal weathering and anthropogenic inputs, we may use the seals as biomonitors of these environmental contaminants.

Automated Detection and Categorization of Whistle Contours for Characterizing the Repertoire of Bottlenose Dolphins
Peter Sugarman¹, Kevin R Coffey², Liz Ferguson³, Jennifer Pettis Schallert⁴, Gabriela Alongi⁵, Heidi Lyn⁶
¹Humans and Dolphins Talking, Bellevue, Washington, ²University of Washington School of Medicine, Seattle, Washington, ³Ocean Science Analytics, San Diego, CA, ⁴BioSci, LLC, Satellite Beach, FL, ⁵Bioacoustic Analyst, San Diego, CA, ⁶University of South Alabama, Ocean Springs, Mississippi

One of the limitations in dolphin communication research is the inability to automatically categorize whistles. A fundamental element of understanding the vocal repertoire of a group of dolphins lies in an accurate understanding of the types of whistles they produce. While effective automated tools exist to categorize species of marine mammals by their signals, within-group repertoires are not commonly described. Whistles contain nuances that a human observer can detect, but pose challenges when objectively evaluated by mathematical or statistical characterization. However, using humans to categorize signals is time intensive and subjective. In order to characterize the repertoire of three captive bottlenose dolphins we developed a new computational method using DeepSqueak software for categorizing 1,290 whistles produced by the group. Results are reported for ability to characterize signals and the resulting categorization. The ability to automatically categorize whistles detected within-group settings enables several research opportunities, from enhanced abilities to correlate physical behavior with vocalizations to designing artificial communication systems for potential human-dolphin interactions.

Development of a web-based database for remote analysis of dolphin clicks recorded at multiple field observatories
Harumi Sugimatsu¹, Junichi Kojima², Tamaki Ura³, Rajendar Bahl⁴
¹Institute of Industrial Science, the University of Tokyo, Tokyo, Japan, ²KDDI Research Inc., Kamifukuoka-shi, Saitama, Japan, ³Deep-ocean Ridge Technology Co., Ltd., Goto, Nagasaki, Japan, ⁴Indian Institute of Technology Delhi, New Delhi, India

A web-based database has been developed for remote analysis of dolphin click data recorded at multiple field observatories. To understand the endangered river dolphin’s migration behavior and echolocation strategy in their habitat, the authors have conducted the field experiments in India (Gangetic dolphin) and Borneo (Irrawaddy dolphin) for years, with the passive acoustic monitoring system (PAM) using an array of hydrophones that can record the high frequency bio-sonar dolphin clicks. The dolphin clicks received on each hydrophone are amplified over a -3dB bandwidth of 10kHz – 200kHz, and digitized at a sampling rate of 500kHz with 16 bits resolution. The system can calculate each
dolphin’s location (XYZ), Inter-click Interval (ICI) and Centroid Frequency (CF). For quantitative analysis of the acquired data from the observatories, however, there is a need for a common platform for analysis that allows relevant researchers to access data from anywhere in the world. Therefore, in the developed database, recorded click data with calculation results (other than the waveform) are transmitted to the host server via internet in real-time, and uploaded to the database every one hour except when the internet connection is terminated. The user first selects the de-noising filtering parameters for extracting dolphin clicks. Parameters used for de-noise conditions are: Apparent Source Level (ASL) and Frequency of a click, dolphin’s XYZ position and its range from the array. To understand the dolphin’s migration behavior, we created pages displaying the dolphins’ XY trajectories and density around the observatory, and the dolphins’ direction around the observatory. To understand the dolphin’s echolocation characteristics, then, we created pages displaying ICI histogram and CF histogram of clicks. Additional pages for further analysis could be added depending on the application. With the database, when users specify the observatory and the designated time, they can obtain the necessary dolphin information anytime and anywhere.

Presenting Whale & Dolphin Tracker – An App for Data Collection and Engaging with Community Scientists

Florence Sullivan¹, Stephanie Stack¹, Joe Breman², Raphael Martelles², Jens Currie¹
¹Pacific Whale Foundation, ²International Underwater Explorations, Haiku, Hawaii

Mobile app-based data collection harnesses the power of engaged community scientists, ubiquitous smartphones, and platforms of opportunity. The ‘Whale & Dolphin Tracker’ application (WDT) was launched in 2017 to enhance real-time data collection efforts aboard platforms of opportunity in the Maui Nui region of Hawaii, USA. Whale & Dolphin Tracker is freely available on Android and iOS and is capable of logging species encounters, GPS location, number of animals, observed behaviors and more. It can also store media associated with encounters such as images and GPS survey tracks. While initially developed for data collection in Hawaii, sightings of any marine megafauna can be submitted from around the globe. A web portal allows any user to easily access, review, and download their sightings and associated data. All WDT submissions are also archived on PWF servers and uploaded to a live sightings map available for public viewing. The ~11,000 user profiles have logged over 15,600 sightings of 15 different species accounting for over 119,300 animals since 2017. This wealth of sightings data has already contributed to scientific publications on topics including: assessments of humpback whale mother-calf area use in Hawaii’s breeding grounds and the distribution of 4 dolphin species and their vulnerability to vessel traffic. Besides the research application, the app can also be used to enhance conservation and education on ecotourism vessels by connecting guests with marine science. Future uses of this globally accessible, real-time database could include establishing baseline knowledge in areas lacking dedicated research survey capabilities, and investigating patterns of species distribution across large spatio-temporal scales. WDT is free, field-tested, has an intuitive interface and can be an easily implemented tool when building relationships between researchers, community scientists, and platforms of opportunity.
Optimization of Environmental DNA for Gray Seal Detection and Population Genetics
Julia Sunnarborg1, Christine Hudak2, Lisa Sette2, Kristina Cammen3
1University of Maine, Bangor, Maine, 2Center for Coastal Studies, Provincetown, Massachusetts,
3University of Maine, Orono, Maine

Gray seal (Halichoerus grypus atlantica) populations in the Northwest Atlantic are currently experiencing population growth after a long history of bounties and exploitation. Effective management of this species relies on an understanding of its population structure and diversity. Environmental DNA (eDNA) provides a non-invasive method of monitoring the presence of marine mammals, but effective methodology is hindered by gaps in our knowledge about how eDNA behaves in the marine environment. The utility of this method for population genetics has also yet to be fully established. This investigation therefore addressed two primary goals: to establish detection and quantification thresholds for sampling eDNA near seal haul-out sites, and to test the efficacy of eDNA for assessing haul-out intraspecific diversity. Gray seal DNA was extracted and quantified from water samples taken at multiple distances from haul-out sites on Cape Cod, Massachusetts, USA. The highest quantity DNA was obtained nearest to shore, but seal presence could still be detected from at least 50 meters away. These results will be used to develop a recommended methodology for eDNA sampling at seal haul-outs, in order to maximize DNA yield while minimizing seal disturbance. Mitochondrial control region haplotypes present in eDNA samples will be compared to those identified from fecal samples collected on the haul-outs, in order to explore the extent to which eDNA can assess intraspecific diversity. This will support future integration of eDNA into marine mammal management practices, increasing our capacity to monitor cryptic, rare, and protected species while minimizing impacts on individuals.

Steroid hormone profiles in grey seal pups during the suckling period and postweaning fast using SFC-MS/MS
Vaida Surviliene1, Shannen Thora Lee Sait2, Suzana Villa Gonzalez3, Alexandros Asimakopoulos1, Kimberley Bennett4, Simon Moss5, Paddy Pomeroy5, Osvaldas Rukšėnas5, Bjorn Munro Jenssen6, Tomasz Ciesielski8
1Institute of Biosciences, Life Sciences Center, Vilnius University, Saulėtekio av. 7, Vilnius, Juodėliai, Vilniaus raj., Lithuania, 2Department of Chemistry, Norwegian University of Science and Technology, Trondheim, Norway, 3Department of Chemistry The Norwegian University of Science and Technology, Trondheim, Norway, 4Abertay University, Dundee, United Kingdom, 5Sea Mammal Research Unit, St. Andrews, United Kingdom, 6Sea Mammal Research Unit, St Andrews, United Kingdom, 7Institute of Biosciences, Life Sciences Center, Vilnius University, Vilnius, Lithuania, 8Trondheim, Norway

Newborn grey seal (Halichoerus grypus) pups undergo a significant physiological shift from short and intense lactation to a postweaning fast that can take up to one month. Steroids hormones are important for successful development in all mammal species. Various environmental factors such as human induced stress, habitat destruction and pollutants can disturb endocrine regulation during the sensitive developmental period of grey seal pups. To evaluate possible adverse effects, reliable methods for the quantification of steroid hormones are needed. We have implemented a recently developed SCF-MS/MS method for the simultaneous detection of 15 steroids in blood plasma: glucocorticoids (cortisol (COR), corticosterone (COS), 11-deoxycortisol (11-deoxyCOR), cortisone (CORNE), 11-deoxycorticosterone (DOC)), estrogens (estrone (E1)), androgens (testosterone (TS), dehydroepiandrosterone (DHEA), 11-ketotestosterone (11-ketoTS), androstenediol (A5), androstenedione (AN), dihydrotestosterone (DHT)) and their precursors (progesterone (P4),
pregnenolone (PREG), 17α-hydroxyprogesterone (17α-OHP)). Blood was collected repeatedly from 9 (31 samples in total) wild grey seal pups during the breeding season in 2017 on the Isle of May, UK. Significant ($p < 0.05$) differences were determined by generalized linear mixed model. COR (21.5 ± 11.4 ng/ml) and CORNE (11.7 ± 4.4 ng/ml) were most prevailing glucocorticoids. A5 (17.9 ± 8.5 ng/ml), DHEA (12.1 ± 13.4 ng/ml) and TS (8.73 ± 7.5 ng/ml) were most abundant androgens and PREG (9.15 ± 7.6 ng/ml) was the most dominant steroid precursor. COS, 11-deoxyCOR and DOC were negatively related to pup’s body mass, COR, CORNE and PREG concentrations were higher in suckling than weaned pups, while AN was found above the detection limits of the method only in female pups. Our study provides reference values for steroid hormones and their precursors in grey seals pups. The results indicate differences in steroid profiles between male and female pups already during early developmental stage and importance of nursing and body mass on steroid concentrations.

**Standardizing Skin Lesion Gross Descriptions in Bottlenose Dolphins (Tursiops truncatus) that Stranded in Southwest Florida**

Meghan Sutton¹, Ruth Ewing², Molly Schubert³, Jill Richardson⁴, Denise Boyd⁵, David Rotstein⁶, Hada Herring⁷

¹Florida Fish and Wildlife Conservation Commission, Punta Gorda, Florida, ²NOAA, National Marine Fisheries Service, Miami, FL, ³Florida Fish and Wildlife Conservation Commission, Port Charlotte, Florida, ⁴University of Miami, Rosental School of Marine and Atmospheric Science, Miami, Florida, ⁵Florida Fish and Wildlife Conservation Commission, Port Charlotte, FL, ⁶Marine Mammal Pathology Services, Olney, Maryland, ⁷University of Florida

Most published studies of skin lesions in bottlenose dolphins (Tursiops truncatus) lack standardized gross descriptions and methodologies for evaluation. As the first line of defense, the integumentary system is critical to comprehensively evaluate dolphin morbidity in stranding response and necropsy. The primary objective of this study was to evaluate the effectiveness of developing an assessment matrix comprised of standardized gross descriptions of skin lesions by reviewing gross images and histological findings from stranded dolphins in the Gulf of Mexico from 2015 to 2019 (n=37). The study area included three counties in southwest Florida: Charlotte, Lee, and Collier. Necropsy reports, histopathology reports, and photographic images collected from stranded dolphins were reviewed. Dolphins were selected for the study based on minimal levels of decomposition, photographic image quality, and detection of skin lesions, with 32 individuals meeting the inclusion criteria. Of these 32 dolphins, 19 presented with natural skin lesions (e.g., infectious, environmentally induced, or unknown sources). Five reviewers of the study described 46 skin lesions utilizing the novel standardized matrix. The most common descriptor selected, in each of the respective matrix categories were head, multifocal to coalescing, moderate (10-30), less than 2 cm, punctate, rounded margins, hyperpigmentation, and flat and smooth texture. The majority of these prevalent descriptors unexpectedly coincided with the occurrence of hydropic degeneration (n=7, 15.2%) and were used to describe confirmed poxviral lesions (n=3, 6.52%). Capitalizing on the unique pathogen tissue tropism and the recognition of certain disease mechanisms in skin changes, this approach of identifying lesion patterns can facilitate differential disease diagnoses and guide ancillary diagnostic testing. The application of the standardized matrix and approach developed in this study can contribute to etiologic identification and monitoring of skin lesions and associated diseases, thus advancing our understanding of dolphin morbidity and mortality.
Effects of Boat-Based Dolphin-Watching Tourism on the Behaviours of Indo-Pacific Humpback Dolphin (Sousa chinensis) off Don Sak, Surat Thani, Thailand
Thevarit Svarachorn¹, Suwat Jutapruet², Per Berggren³, Matt Sharpe⁴
¹Newcastle University, Newcastle upon Tyne, United Kingdom, ²Department of Fishery Resources, Faculty of Innovative Agriculture and Fishery, Prince of Songkla University, Surat Thani Campus, Surat Thani, Thailand, ³Newcastle University, School of Natural and Environmental Sciences, United Kingdom, ⁴Newcastle University, United Kingdom

This study investigated the potential effects of dolphin-watching tourism on the behaviours of Indo-Pacific humpback dolphins (Sousa chinensis) off Don Sak, Surat Thani, Thailand, by comparing dolphin group behaviours when tourist boats were present (impact) and absent (control). Shore-based dolphin group follows (n = 74) were conducted during 55 days between February and April 2020 at Laem Thuat Pier using scan sampling methods to collect dolphin behavioural data and tourist boat activities. Dolphin behavioural budgets (proportion per day) and behavioural transitions (transition probability) between control and impact sessions were constructed and compared using Markov Chain analysis. The results showed that dolphins significantly decreased the proportion of time spent resting (from 43% to 23%) and increased the proportion of time spent socialising (from 13% to 19%) and travelling (from 3% to 22%) when tourist boats were present. Tourist boats significantly affected 8 of 16 dolphin behavioural transition types. Dolphins were more likely to start travelling and less likely to stay in foraging, resting and socialising activities in the presence of tourist boats as inferred from the Markov chain analysis. This study provides a first independent investigation of dolphin-watching tourism in Thailand and demonstrates that the current activities off Don Sak impact the short-term behaviours of Indo-Pacific humpback dolphins. The apparent changes in dolphin behaviours due to the presence of tourist boats may ultimately reduce dolphin fitness at both individual and population levels. The results highlight the need for management to minimise potential long-term negative effects on the dolphins off Don Sak, Surat Thani, Thailand.

Identifying consensus on conservation policy and incentives to disengage from illegal activity in an artisanal fishery generating high rates of mortality for endangered Caspian seals
Linas Svolkinas¹, Simon Goodman², George Holmes¹
¹University of Leeds, Leeds, United Kingdom, ²Institute of Integrative and Comparative Biology, University of Leeds, Leeds, United Kingdom

In the Caspian Sea illegal fisheries have pushed the five resident sturgeon species to the brink of extinction and generate high rates of by-catch mortality for the endangered, endemic Caspian seal (Pusa caspica). To date attempts at management have focused on bolstering law enforcement and fisheries regulations. These do little to reduce underlying incentives to participate in lucrative illegal activities. Studying perceptions among fishers and other stakeholders on biodiversity, socio-economic factors, and fisheries regulations allows areas of difference and consensus relevant to policy on unsustainable resource use and trade in wildlife products to be identified. A Q-study was carried out in autumn 2018, with 52 stakeholders, including illegal fishers, seal hunters and illegal supply chain stakeholders from Dagestan (Russian Federation). Participants were asked to evaluate statements relating to themes including value of fisheries and seals, sustainable use of resources, perceptions of authorities, local communities, and regulations. Three distinct
stakeholder groups emerged from a factor analysis, which we designated as “nostalgists”, “optimists” and “pessimists”. Nostalgists emphasised a need for increased centralised involvement of authorities as under the Soviet system. Optimists expressed support for the legal fisheries sector and regulation in the restoration of biodiversity. Pessimists were strongly aware of unregulated fisheries and illegal trade in seal products and think that current regulation attempts cannot reverse biodiversity loss. We identified alignment on desire for alternative sources of incomes to fishing, protected areas, sustainability and increased regulation. These consensus areas indicate that communities are willing to reduce participation in illegal fishing with support from authorities. The socioeconomic factors driving illegal fisheries bycatch for Caspian seals parallel those for other endangered marine mammals such as Vaquita, and suggest that Q studies could be applied in other artisanal with high rates of marine mammal bycatch to help identify policy interventions supported by involved communities.

Changes in behaviour of narwhal (Monodon monoceros) in response to shipping noise, predation by killer whales (Orcinus orca), and Inuit hunting.
Sam Sweeney¹, Phillippe Rouget², John M. Terhune³
¹University of New Brunswick Saint John, ²Golder Associates Ltd., Victoria, British Columbia, ³University of New Brunswick, Saint John, New Brunswick

Shipping is increasing in Arctic regions, exposing previously naïve marine mammal populations to underwater shipping noise. The presence of shipping, killer whales and Inuit hunting activity were examined in an area of narwhal summer habitat in Northern Baffin Island (72.066°N, 80.476°W). The goal was to determine if shipping elicited responses by narwhals that resembled responses to the other stressors. Data were collected from land-based surveys at Bruce Head, AIS locations of ore carriers and other ships, and noise levels from a bottom mounted recorder. Each stressor was examined when no others were present. Narwhal relative abundance in a large study area (90.5 km²) was tested before, during and after the presence of each stressor. Fine scale behaviour was examined in a smaller, nearshore study area (∼550 m²) in the presence of each stressor and compared to control settings with no stressors present. The relationships between narwhal behaviour and noise levels (weighted for narwhal hearing abilities) when ships were nearby were examined. Narwhals vacated the study area after the arrival of killer whales and swam closer to shore at faster speeds towards a nearby bay for refuge. Hunting resulted in similar near-shore behavioral changes but with less obvious changes in relative abundance in the larger study area. Narwhal relative abundance did not decrease during ship presence compared to before, and abundance increased after ships passed. Narwhal behaviour in the presence of shipping did not significantly change except for a lower likelihood of herding behaviour. No relationship was found between narwhal behaviour and noise levels in the presence of shipping. Shipping frequently occurred in conjunction with other stressors, limiting observations of behavior in the sole presence of shipping. Overall, narwhal behavior in the presence of shipping did not resemble antipredator responses exhibited by narwhal in the presence of other stressors.

Cuvier’s Beaked Whale Behavioral Responses Persist After Conclusion of Some Navy Sonar Exposures
David Sweeney¹, Erin Falcone², Stephanie Watwood³, Stacy DeRuiter⁴, Gregory Schorr⁵
¹Marine Ecology and Telemetry Research, ²Marine Ecology and Telemetry Research, Seabeck, Washington, ³US Naval Undersea Warfare Center, Newport, Rhode Island, ⁴Calvin
Cuvier’s beaked whales (*Ziphius cavirostris*: Zc) satellite tagged (n = 16; 88 days of tag data) on a military training range in Southern California increased dive and surface durations when opportunistically exposed to navy mid-frequency active sonar (MFAS), thus increasing time between deep, presumed foraging dives—likely indicating foraging disruption. Disruptions intensified with MFAS proximity and were more pronounced during mid-power (dipping helicopter) than high-power (ship based) MFAS. To evaluate the persistence of behavioral responses after exposures, we calculated Mahalanobis distances (MDs) for deep dive cycles (DDCs; a deep dive and subsequent shallow dives and surfacings) based on deep dive depth and duration, shallow dive count and duration, and surface duration to determine how DDCs following MFAS differed from baseline DDCs recorded during extended periods without MFAS. Since many exercises included multiple sonar bouts, sometimes from various platforms and distances, we defined a MFAS exposure as all sonar bouts within 100 kilometers of the whale during consecutively exposed DDCs. We used generalized additive models to assess MDs as a function of sonar type interacting with: time since MFAS ended, closest exposure distance, duration of sonar silence preceding exposure, and number of bouts within the exposure. Although sample size occasionally limited interpretation, model results suggest exposures of both MFAS types can elicit lasting responses. Number of high- and mid-power bouts, sonar silence duration preceding high-power MFAS, and mid-power exposure distance significantly predicted MDs over time. Under certain exposure scenarios, these predictors caused MDs to remain elevated following exposure, although effect sizes varied. 71.1% of exposures began within 2 days of the preceding exposure. These results supplement previous analyses of Zc sonar responses in Southern California that aid mitigation efforts aimed at reducing the effects of training activities on this Zc population.

Dynamics of cetacean mixed-species groups: a review and conceptual framework for assessing their functional significance
Jonathan Syme¹, Jeremy Kiszka², Guido J. Parra³
¹Flinders University, Australia, ²Florida International University, North Miami, Florida, ³Cetacean Ecology, Behaviour and Evolution Lab, Flinders University, Bedford Park, SA, Australia

Individuals of different species are thought to form mixed-species groups (MSGs) to reduce predation risk, improve foraging, and gain social benefits. Numerous cetacean species have been recorded in potential MSGs, however, most accounts are descriptive, so little is known about the functions of these behaviours. We reviewed the cetacean literature to assess the characteristics of cetacean MSGs and evaluate their potential functions. We reviewed 203 studies reporting cetacean MSGs. Cetacean MSGs involved 54 different species, predominantly delphinids, forming 216 species pairs that displayed a range of morphologies and relatedness. Cetacean MSGs occurred across the globe, from tropical to cold temperate seas, from coastal waters to the open ocean, and varied in characteristics such as group size and frequency of occurrence. Only 27 of the reviewed studies proposed and discussed the potential function of cetacean MSGs, suggesting reduced predation risk (5 species pairs), improved foraging (17 species pairs), and social benefits (12 species pairs) as the main drivers. In most cases, however, the factors that drive the formation of cetacean MSGs remain unknown.
Drone and tag data collected simultaneously suggest that bubble-nets are tools used by solitary foraging humpback whales to improve foraging efficiency

Andrew Szabo\(^1\), Lars Bejder\(^2\), William Gough\(^3\), Jeremy Goldbogen\(^4\), Ari Friedlaender\(^5\), Hunter Warwick\(^6\), Marie Angot\(^6\)

\(^1\)Alaska Whale Foundation, Petersburg, Alaska, \(^2\)Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, Hawaii, HI, \(^3\)Stanford University, Pebble Beach, CA, \(^4\)Stanford University, Pacific Grove, CA, \(^5\)University of California Santa Cruz, Santa Cruz, California, \(^6\)Murdoch University, Murdoch, Australia

Humpback whales (Megaptera novaeangliae; HBW) have been observed using bubble-nets - vertical cylinders of air expelled from their blowholes - while foraging on a variety of prey species in several regions around the world. Previous studies have described aspects of the underwater swimming behavior and group dynamics of bubble-netting HBWs inferred from animal-borne sensors and surface observations. Here, we incorporate unoccupied aerial systems (drones) equipped with laser altimeters and associated photogrammetry techniques together with CATSCam suction-cup tri-accelerometer video tags to describe the structure of bubble-nets and the behavior of HBWs in greater detail than previously available. Using drones, we observed 24 HBWs producing 109 bubble-nets while foraging individually on krill in Southeast Alaska. At the surface, nets appeared as up to six internally tangent rings (mean = 3 ± 1.3). UAS-derived measurements of the 2-dimensional area of these rings revealed the outermost ring to be, on average, 6.7 (± 5.1) times larger than the innermost ring (range 1.9 – 23.6 times). If krill are contained by the bubble rings, as has been demonstrated for other HBW prey species, this decrease in ring area - and by extension net volume - would lead to a proportional increase in prey density. CATSCam data from five tagged HBWs indicated that they began expelling air at a depth of 22.0 ± 4.4 m, which was broadly correlated with the uppermost scattering layer observed concurrently on the vessel’s depth sounder. While ascending through the bubble-net, whales reached a maximum speed of 2.1 ± 0.2 ms-1, which is substantially slower than speeds reported for HBWs lunge feeding on krill without nets. Given the high energetic costs associated with lunge-ing in rorquals, these data suggest HBWs use bubble-nets as tools to increase their foraging efficiency by both concentrating their prey and reducing the energetic costs associated with lunge-feeding.

It’s only with eDNA that one can see rightly – metabarcoding across the Atlantic Ocean in search of cetaceans

Dora Szekely\(^1\), Claire Lacey\(^1\), Kerry Froud\(^1\), Anna Moscrop\(^2\), Owen Wangensteen\(^1\), Kim Præbel\(^1\), Morten Tange Olsen\(^1\)

\(^1\)University of Copenhagen, Copenhagen, Denmark, \(^2\)Marine Conservation Research, Kelvedon, Essex, United Kingdom, \(^3\)UiT The Arctic University of Norway, Tromsø, Norway, \(^4\)Tromsø, Norway, \(^5\)Institute of Biology, University of Copenhagen, Copenhagen O, Denmark

Monitoring cetaceans with the use of environmental DNA (eDNA) is a novel approach in marine mammal research. Collecting water samples from the close vicinity of individuals is simple, inexpensive and nevertheless non-invasive, thus eDNA has a potential in complementing traditional survey methods. Cetaceans are often elusive and difficult to spot, hence proof of their presence is limited to human capabilities and acoustic monitoring on a regular basis. It is needed to fill out the gaps in knowledge on the diversity, distribution and habitat of cetacean species and eDNA has proven reliable in many water-based ecosystems. Based on our current knowledge, eDNA originating from cetaceans in seawater has a
relatively short detectability due to different environmental variables (UV, temperature, microbial activities and currents) and considered a real-time indicator of their presence. In this study we tested if eDNA has the capacity to detect cetacean species that are present in the area using a combined metabarcoding and acoustic monitoring approach. The sailing boat Song of the Whale surveyed the Atlantic Ocean – from the UK to the Antarctic region (Falkland Islands) and back, during which surface water samples were taken whenever the presence of a cetacean was confirmed visually or acoustically. Extracted eDNA samples were amplified using a metazoan (COI) and a marine vertebrate primer set (12S rRNA) to cover the eukaryotic domain with a higher resolution on marine vertebrates. Samples were sequenced on an Illumina NovaSeq platform. The results show that while metabarcoding eDNA to detect cetaceans is a promising tool, there is a dire need to expand the reference database with genetic information on rare cetacean species in order to be able to confidently detect their presence in unexplored habitats.

Resight and Survival of Entangled Humpback Whales Within the California, Oregon, and Washington Region Using Photo-identification and Long-Term Life History Data
Jennifer Tackaberry¹, Elana Dobson², Kiirsten Flynn³, Ted Cheeseman⁴, John Calambokidis⁵
¹Cascadia Research Collective; Center for Coastal Studies, Pacific Grove, CA, ²Cascadia Research Collective, ³Cascadia Research Collective, Olympia, Washington, ⁴Southern Cross University, ⁵Cascadia Research Collective, Olympia

Entanglements are a leading source of human-caused mortality of humpback whales, Megaptera novaeangliae, along the US West Coast. A better understanding of the individuals that survive (or perish from) their entanglement can inform gear modifications, management measures, and overall population dynamics. Historically, the effort to identify and resight individuals from known entanglement cases was low, (no photo-identification link prior to 2007 in California, Oregon, and Washington region). The recent increase of entanglements accompanied by photo-identification in this region provides an opportunity to assess entangled humpback whales' resight rates. We used photo-id images of entangled whales between 1982-2017 to examine pre- and post-entanglement sighting histories from longitudinal catalogs and life history data (Cascadia Research and Happywhale) against a control group based on the date and location of the entanglement reports (n=37) to evaluate the deviation from the expected mortality rates (or lack of resighting) caused by entanglements as well as help (inform/support/test) NOAA’s Serious Injury and Mortality index. Our results suggest that entangled whales were resighted less often than the control groups. Entangled whales with short pre-entanglement sighting histories and without post-entanglement resights did not match other feeding ground populations. Therefore, the higher proportion of entanglements with shorter sighting histories (likely due to being alive for fewer years) may signify a higher risk of entanglement for younger whales. This indicates that entangled humpback whales may not be as large or strong as mature individuals, and future gear modifications should reflect that possibility. Additionally, the severity of the initial NOAA Serious Injury (SI) score aligned well with our resighting rates, though this worsened with the final score assigned. Continued effort to gather and improve photo-identification methods will help enhance the SI determinations. Our findings show the value of collecting photo-identification of entangled whales and how it dramatically increases our understanding of entanglements.
SIREN mobile-App and citizen-generated data to protect marine mammals in Cameroon
Eddy Nnanga¹, Cedrick Fogwan², Cedrick Ingrid Biankeu³, Aristide Takoukam Kamla⁴

In Cameroon, as in many low-income countries, aquatic megafauna species such as whales, dolphins, manatees are poorly known. Surveys and monitoring in the aquatic environment can be very costly and required skills locally unavailable. However, those species seem are mostly threatened by poaching, accidental catch, and habitat degradation whose impacts on their populations remain unknown. Without a good knowledge of the population dynamic, distribution, and threats to these species, they may go locally extinct before being scientifically discovered. In response to this knowledge and skill gaps, we established along the 400-km coastline of Cameroon the first aquatic citizen science program, with over 80 fishermen who voluntarily report opportunistic sightings of aquatic animals they observe during their normal fishing activities. The report is made using the SIREN App that we developed to ease and secure the sharing of the observations. Fishermen who demonstrated commitment to sharing observations were provided with a smartphone and trained. The pilot phase of this program started in 2014 with only 10 fishermen, in 2019 we scaled it up to the entire coast of Cameroon. The fishermen have recorded between 2015 and 2020 over 12655 sightings, mostly (87%) dead aquatic animals from 374 species spread in 6 groups including marine mammals (1.2%), sea turtles (1.4%), elasmobranchs (19%), and fishes (72.5%). A total of 144 marine mammal sightings was reported, mostly African manatees (62%). The citizen-generated data allowed us to identify the species of marine mammals that occurred along the coast of Cameroon and map their threats and hotspots. Our results highlight the crucial need to intensify efforts to protect the African manatee because of the high-level dead report. Through our citizen science, we were able to successfully advocate for the legal protection of two dolphins (including the critically endangered Atlantic humpback dolphin) and two whale species in Cameroon and converted some fishermen into conservation heroes.

A fatty acid signature library of prey fish for common bottlenose dolphins (Tursiops truncatus) for use in quantitative fatty acid signature analysis (QFASA)
Theresa-Anne Tatom-Naecker¹, Randall Wells², Daniel Costa³, Stephen Trumble⁴, Aaron Kirkpatrick⁴
¹University of California Santa Cruz, Santa Cruz, CA, ²Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, Florida, ³Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA, ⁴Baylor University, Waco, Texas

Obtaining a detailed, long-term understanding of cetacean diet is critical to evaluating their vulnerability to disturbances that impact access to prey, such as harmful algal blooms, fishing, and climate change. Quantitative fatty acid signature analysis (QFASA) provides a months-long record of prey species proportions in predator diet by comparing the fatty acid signature (FAS) of a predator’s blubber and model diets created from a prey FAS “library”. However, QFASA is rarely used in cetaceans, in part due to the challenges of developing a prey library. As part of our application of QFASA to evaluate the diet of resident common bottlenose dolphins (Tursiops truncatus) in Sarasota Bay, Florida, we created a local prey library and analyzed the seasonal variation in FASs. When within-species variation in prey FASs across seasons is less than between-species variation,
individual species can be identified in the diet. In cases of overlap among species based on factors like diet guild or phylogeny, common prey types may be pooled prior to QFASA. Each month during January through March and June through September 2020, we collected 3-5 individuals of each species caught during seasonal purse seine fishing, part of prey fish monitoring conducted since 2004. We homogenized 458 fish from 45 species, extracted lipids from replicate aliquots using a Soxtec apparatus, derivatized fatty acid methyl esters, and quantified the fatty acid signatures using gas chromatography with flame-ionization detection. Non-metric multidimensional scaling was used to assess the variation among prey species and determine any overlapping prey types. The resulting prey library brings us one step closer to obtaining a detailed, long-term view of Sarasota Bay common bottlenose dolphin diet and disturbance vulnerability. Furthermore, understanding the degree of within- and between-species variation among prey fish FASs, across seasons, can inform the creation of prey libraries in other QFASA studies.

Persistent organic pollutants in the blubber of free-ranging common bottlenose dolphins, *Tursiops truncatus*

Sena Tay¹, Brian Balmer², Irvin Schultz³, Keri Baugh⁴, Jennie Bolton⁵, Emily Griffin⁶, Robin Perrtree⁷, Tara Cox⁷

¹Savannah State University, Savannah, GA, ²National Marine Mammal Foundation, Johns Island, SC, ³Northwest Fisheries Science Center, NOAA, Seattle, WA, ⁴Environmental and Fisheries Sciences Division, Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, seattle, wa, ⁵NOAA Fisheries, Seattle, WA, ⁶University of Florida, Gainesville, Florida, ⁷Savannah State University, Savannah, Georgia

Persistent organic pollutants (POPs) are lipophilic chemicals that occur in marine ecosystems globally and bioaccumulate in fatty tissues of organisms at higher trophic levels. POPs are resistant to environmental degradation and have a potential for long-range transport. High POP concentrations in marine mammals have been associated with endocrine disruption, immune suppression, and potential increased susceptibility to disease. The widespread distribution of common bottlenose dolphins, *Tursiops truncatus*, and high lipid content of this apex predator make them an ideal sentinel species for biomonitoring spatial and temporal trends in contaminants. Remote biopsy samples (n = 82; 2017, 2019) and long-term photo-identification data (2009-2019) collected in the Wilmington River Estuary (WRE), Georgia were used to determine contaminant concentrations and compare across spatial and temporal scales. Skin samples were sexed using genetic testing, and blubber samples were analyzed for a suite of POPs using gas chromatography/mass spectrometry. Polychlorinated biphenyls ($\sum$PCB₄₅) were the contaminant class with the highest mean concentration in both adult male (35.5 ± 18.8 $\mu$g/g lipid) and adult female (8.1 ± 7.8 $\mu$g/g lipid) dolphins. The levels of $\sum$PCB₄₅ in WRE male dolphins were in the lower third of values measured in other sites across the southeastern U.S. In addition, WRE male dolphins had $\sum$PCB₄₅ levels that were several times lower than those measured in a field site ~90 km south (Brunswick, GA: 450 $\mu$g/g lipid, geometric mean). Reproductively active females had lower contaminant levels (6.2 ± 5.9 $\sum$PCB₄₅ $\mu$g/g lipid) than those that had never been observed with a calf (28.5 ± 19.1 $\sum$PCB₄₅ $\mu$g/g lipid). The relatively low contaminant concentrations identified in this study suggest that WRE dolphins may be a reference population for future contaminant studies.
Using Expert Elicitation To Estimate Numbers Of Vaquitas And Calves Seen

Barbara Taylor¹, Lorenzo Rojas-Bracho², Len Thomas³, Cormac Booth⁴, Annette Henry⁵
¹SW Fisheries Science Center, La Jolla, CA, ²Ocean Wise, Ensenada, Baja California, Mexico, ³CREEM, University of St Andrews, St Andrews, Fife, United Kingdom, ⁴SMRU consulting, St Andrews, United Kingdom, ⁵NOAA Southwest Fisheries Science Center, La Jolla, CA

Fewer than 19 vaquitas remained in 2018 according to the last published estimate based on acoustic monitoring. However, acoustic monitoring is no longer possible because of theft of recording devices. An attempt at a photographic mark-recapture estimate was made in 2019. Experienced vaquita observers used 25x binoculars to search the 12x24km area with the last vaquita acoustic detections. Surviving vaquitas are wary so only a few distant photographs were obtained. Some sightings had no photographs, and there were no photo-based recaptures, making a mark-recapture estimate impossible. Yet, managers need to know whether vaquitas remain viable for recovery. We therefore undertook an expert elicitation (EE) with the observers to obtain distributions on the numbers of unique vaquitas and calves seen. Observers were trained in EE and participated in 6 hours of facilitated zoom meetings. The elicitation used an evidence dossier that recorded all pertinent data. Observers independently recorded the lowest and highest number of calves plausible and their quartiles. Each expert then explained their choices to the group. After discussion, experts were allowed to change their values. The facilitator then led the group to a single distribution that a ‘Rationale Independent Observer’ would agree captured the groups’ beliefs. The resulting distribution gave highest likelihood to 3 unique calves and a probability of 0.97 that 2 or more unique calves were sighted. A similar process was followed for the total number of unique vaquitas, resulting in a distribution with highest likelihood of 11 unique vaquitas were sighted and a probability of 0.71 for 10 or more. These estimates provide optimism for recovery if bycatch were halted because they are consistent with nearly all adult females having calves. The exercise also suggested improvements for future efforts to conduct the elicitation process during fieldwork. These methods could be used for other highly endangered marine mammals.

Use of Clustered Mark-Recapture Methods to Monitor Bottlenose Dolphins (Tursiops truncatus) in the Outer Banks, North Carolina

Jessica Taylor¹, Holly Fearnbach², John Durban³, Jeff Adams⁴
¹Outer Banks Center for Dolphin Research, Kill Devil Hills, North Carolina, ²SR3, SeaLife Response, Rehabilitation and Research, Seattle, WA, ³Oregon State University, ⁴NOAA, Fisheries, Silver Spring, Maryland

This study examined the dynamics of a seasonally-occurring bottlenose dolphin population in Roanoke Sound, North Carolina. From 2008-2017, 170 photo-identification surveys were conducted from which 717 distinctive dolphins were identified. A hierarchical Bayesian mark-recapture model was used to identify population clusters based on similarities in identification probabilities across years. Dolphins were assigned with maximum probability to three distinct clusters, and most (599/717) individuals could be assigned to a specific cluster with high probability. Clusters differed in average annual identification probabilities (C1, p=0.83; C2, p=0.56; C3, p=0.11), and dolphins abundance estimates differed by cluster (average annual abundance of N1=23, N2=25, N3=654). Bayesian posterior predicative methods revealed a plausible fit for only C1 and C2 (p-values = 0.48, 0.47; compared to 0.5 if consistent with data) and not C3 (p-value = 0), indicating lack of power for mark-recapture
monitoring of the large number of “transient” individuals that use the study area much less frequently. In contrast, for both the “resident” C1 and “regular” C2 clusters, the average annual number of deaths (or permanent emigrants; D1=1, D2 =2) was balanced by recruitment (R1=1, R2=2), inferring stable populations. We found a high degree of transient site fidelity (C3) in addition to a small number of residents (C1 and C2) in Roanoke Sound. C1’s and C2’s high identification probability enabled monitoring real population dynamics that were not confounded by catchability problems. This study demonstrates the importance of describing population structure and monitoring changes over time so that appropriate management measures can be implemented. This study also emphasizes the usefulness of this modeling technique in examining the dynamics of a mobile marine predator.

A Sensitive Quantitative Measure of Gray Whale Body Condition Shows Changes in Condition within Season and Across Years in Puget Sound, Washington
Kira Telford1, John Calambokidis2, Erin Meyer-Gutbrod2, Kiirsten Flynn4, Alie Perez5, James Fahlbusch6, Holly Fearnbach7, John Durban8
1Cascadia Research Collective, University of South Carolina, Chicago, IL, 2Cascadia Research Collective, Olympia, 3University of South Carolina, Columbia, SC, 4Cascadia Research Collective, Olympia, Washington, 5Cascadia Research Collective, Olympia, WA, 6Stanford University, Cascadia Research Collective, Pacific Grove, CA, 7SR3, SeaLife Response, Rehabilitation and Research, Seattle, WA, 8Oregon State University

Conducting health assessments on a population is an important step in understanding the trends in a population’s health, the factors that may be affecting it, and can lead to better management and conservation efforts. We report on the development of a new quantitative assessment method to measure gray whale health that is sensitive enough to measure fluctuations over months and provides a way to measure health across years. Past assessments had used a subjective 3-point scale to score body condition based in part on the dip behind the post-cranial hump. We measured the downward angle (using ImageJ software) to the dip behind the post-cranial hump based on a reference line from the post-cranial hump to a set point along the back of the whale. We tested this new methodology on a group of about a dozen gray whales (called Sounders) that Cascadia Research has conducted photo-identification on since 1990 and that come to the waters of northern Puget Sound, Washington every spring to feed on ghost shrimp. We measured 783 photographs taken from 1990 to 2020 of primarily the annually returning Sounders and tested for the significance of changes by Julian Day, Individual, and Year. Julian Day (when controlled for year and individual) was highly significant and showed improvement of body condition even over the few months Sounders gray whales feed in northern Puget Sound. This confirmed that this approach is highly sensitive for measuring body condition changes within individuals (where we could use consistent reference points). We are now testing this method against UAS-based measurements of body condition being conducted concurrently. This methodology will lead to a better understanding of the health of the population and provide the opportunity to compare the trends in health to shifts in environmental and/or anthropogenic factors.

Evolution of HOXD13 gene in cetaceans shows lifting selective constraints for limb patterning
Valeriia Telizhenko1, Michael McGowen2, Pavel Gol’din3
1I.I. Schmalhausen Institute of Zoology of National Academy of Sciences of Ukraine, Kyiv, Ukraine, 2Smithsonian National Museum of Natural History, 3I.I. Schmalhausen Institute of
5’-terminal Hox genes are among the key regulators of limb development and patterning in tetrapods. Expansions of the polyalanine tract at the 5’-end of the HOXD13 protein are known to be a possible cause of the formation of flipper-like appendages in cetaceans. However, the relation between HOXD13 evolution and evolutionary transformation of the mammalian limb remained unclear. In this study, molecular evolution approach was used for testing whether HOXD13 gene underwent the selective pressure in cetaceans. Ortologous sequences of HOXD13 for 19 cetacean and 17 non-cetacean mammals were obtained using BLAST search on GenBank database. Additionally, HOXD13 partial coding sequences for 27 cetacean species were obtained de novo. Multiple sequence alignment of predicted protein sequences demonstrated anomalies (insertions and deletions of residues, alanine to valine replacement) in polyalanine tract at the 5’-end of HOXD13 in most of the examined cetaceans except Berardius bairdii, Lagenorhynchus acutus and Steno bredanensis. The maximum number of alanine residues was 18, and in these cases a distinct paedomorphic morphotype of the manus skeleton was seen. For the complete coding sequences, the selective pressure was evaluated using branch and branch-site models in codeml program in PAML 4.8. Although the branch model showed significant differences (p < 0.05) in some cetacean lineages (Tursiops spp., Platanista minor), the branch-site approach did not identify sites under positive selection. However, the test for selection relaxation showed significant value (p = 0.013) for the cetacean clade. Thus, negative selection in HOXD13 in cetaceans is significantly weaker than in the other mammals. These results indicate the role of relaxation of selective constraints in the evolution of cetaceans. Importantly, expansion of the polyalanine tract was found in the walrus Odobenus rosmarus and dugong Dugong dugong, showing its parallel evolution in marine mammal lineages.

Human activities have radically altered ecosystems globally, creating novel pressures on ecological processes. Rising levels of anthropogenic noise overlap important frequency ranges used by animals for critical biological activities. Understanding whether noise interferes with foraging ecology of odontocetes has been limited by the challenge of identifying successful prey capture events. We addressed this challenge, using biologging data collected contemporaneously from two populations of fish-eating killer whales (Orcinus orca) residing in the coastal waters of the northeastern Pacific Ocean, to (1) compare noise levels between populations, and (2) investigate noise level as a predictor of foraging ecology. Using sound and movement data from suction cup-attached Dtags deployed on 52 individuals from the Northern and Southern Resident killer whale populations between 2009-2014, we developed selection criteria to measure broadband ambient noise levels at low-frequency cut-offs uncontaminated...
by flow noise, and applied acoustic and kinematic detection of foraging behavior, to compute foraging metrics including foraging and success rates and searching effort. We constructed mixed effects models using a GLMM framework to determine the importance of noise level and other predictors including population, sex, and year on foraging metrics, and iteratively dropped non-significant terms. We found a significant effect of population on maximum noise level measured between 15-45 kHz within a dive. Furthermore, maximum noise level within a dive was a significant predictor of increased likelihood of clicking, reduced likelihood of buzzing and smaller maximum dive depth. Moreover, minimum noise level within a dive was a significant predictor of reduced likelihood of prey capture. These findings lend further support to the hypothesis that noise may be limiting foraging opportunities and/or success. We discuss the implications of noise-induced interference on the foraging ecology of these two populations of killer whales that have exhibited divergent trends in population growth and recruitment over the past two decades.

Communication sounds produced by captive narrow-ridged finless porpoises
Tomoyoshi Terada1, Tadamichi Morisaka2, Ikuo Wakabayashi1, Motoi Yoshioka4
1Mie University, Japan, 2Cetacean Research Center, Mie university, Tsu, Mie prefecture, Japan, 3Toba Aquarium, Toba, Mie, Japan, 4Mie University, Tsu, Mie, Japan

The narrow-ridged finless porpoise (Neophocaena asiaeorientalis) does not produce the whistles that many delphinid species use for communication, but produces narrowband, high-frequency, pulsed sounds. Here, we show two types of their pulsed sounds, including a new sound type that is used for communication. The sounds and behavior of six captive porpoises (two males and four females) were recorded at Toba Aquarium, Japan, and distributed into three recording contexts: isolation, two, and four porpoises. The sounds were first classified visually by checking the spectrograms. We then quantitatively defined sound types according to the visual classification. As a result, we identified two sound type candidates for acoustic communication. A “packet sound” is a pulse sequence with repeated pulse packets (sound series of a few pulses with irregular, short interpulse intervals; IPI). A “burst pulse” is a pulse train in which IPIs are significantly shorter than packet sounds. We compared the frequency and probability of the production of the two sound types among the three recording contexts and between behaviors to investigate the function of these sound types. Packet sounds were produced more in the context of isolation than in other contexts ($p < 0.001$; Steel-Dwass test). This was a feature of the contact calls, which were similar to those of common bottlenose dolphins and beluga whales. Therefore, we suggest that packet sounds in narrow-ridged finless porpoises are communication sounds, specifically contact calls. A burst pulse was related to back-rubbing and mating behavior ($p < 0.05$; Wilcoxon signed-rank test). We suggest that the burst pulse is also a communication sound. The narrow-ridged finless porpoise has an acoustic communication system that uses pulsed sounds.

Exploring Bottlenose Dolphins Pair Swimming Position Patterns in Non-Mother/Calf Dyads
Manon Themelin1, Kathleen Dudzinski2
1Dolphin Communication Project, Auvers Sur Oise, France, 2Dolphin Communication Project, Port Saint Lucie, Florida

Focusing exclusively on non-mother/calf dyads, different pair swimming positions (PSP) of bottlenose dolphins were explored to identify any pattern(s) according to the type of pair swimming, and as related to age, sex, and kin dyad combinations. Data from a longitudinal study of bottlenose dolphins housed in a natural
lagoon at the RIMS were used. Five PSPs were defined: infant, echelon, parallel, staggered-parallel, and stacked. Pair swimming involving exclusively adults and/or subadults and pair swimming involving adults and subadults with juveniles and calves were analyzed separately due to the potential of alloparental care in the latter category. In adults/subadults, female dyads spent 50% of PSP in infant position, which increases to 81% for mixed-sex dyads, while male dyads have 80% of their PSP in either parallel or staggered-parallel positions. For adults/subadults, 78% of PSP were between non-kin. In pairs of adults/subadults with juveniles/calves, no female dyads were observed in any PSP. Mixed-sex and male dyads were mostly observed in infant position (91% and 69%, respectively), with male dyads also spending 30% of PSP in either parallel or staggered-parallel positions. For adults/subadults with juveniles/calves, 57% of PSP were between non-kin and 43% between kin. These first results show that various PSPs are used differently depending on the dyad age, sex, and kin combinations, which implies different benefits and functions for each position. Furthermore, some individuals engaged in PSP for 20% of their total time observed, while others used PSP only 3%, which demonstrates individual variability. Taken together, these findings show PSP in dolphins is complex with each position potentially offering different hydrodynamic and social advantages that need further consideration.

Climate Change Impacts on Marine Mammals in North America: Predicted, Observed, Unknown
Peter Thomas¹, Jason Baker², Frances Gulland³, Marian Howe⁴, Erin LaBrecque⁵, Sue Moore⁶, Randall Reeves⁷
¹Marine Mammal Commission, Bethesda, Maryland, ²Protected Species Division / NOAA / PIFSC, Honolulu, HI, ³Marine Mammal Commission, San Rafael, CA, ⁴Marine Mammal Commission, ⁵U.S. Marine Mammal Commission, ⁶University of Washington, Seattle, WA, ⁷Okapi Wildlife Associates, Hudson, Quebec

By the mid-1990s, scientists had begun to recognize and publish on the potential for climate change to induce profound impacts on marine mammals. The subsequent decade saw a proliferation of studies aiming to predict which species were likely to be most affected, and by which mechanisms. These studies frequently focused on how projected sea ice reductions might influence Arctic marine mammals, but potential effects globally were also assessed. Now, roughly two decades later, speculation is no longer necessary, as numerous climate change impacts on the animals and their habitat have been realized. We review observed impacts on marine mammals relative to predictions, with a focus on North America. Observed responses have occurred at an accelerated pace concomitant with rates of sea ice loss, ocean warming and freshening that have exceeded predictions. In addition, unforeseen and relatively acute consequences have been documented. These impacts can occur when animal responses to climate-induced ecosystem alterations cause increased morbidity or mortality due to human activities as well as to realignment of natural ecological relations. Examples include: (i) range shifts in North Atlantic right whales leading to fishing-gear entanglements and ship strikes in areas where such interactions had been rare, (ii) increased extent and duration of harmful algal blooms off California causing toxicosis in marine mammals, (iii) inundation of terrestrial habitat leading to unprecedented mortality of Hawaiian monk seal neonates due to both shark predation and drowning, and (iv) a marine heatwave greatly intensifying the overlap between a crab fishery and foraging whales, resulting in an unprecedented number of entanglements. Mitigating the threats of climate change to marine mammals will require research and monitoring specifically designed to detect impacts, followed by agile management and both
conventional and novel conservation interventions.

Maintaining Control: Metabolism of Molting Arctic Seals when Hauled Out and in Water
Nicole Thometz¹, Holly Hermann-Sorensen², Madeline Meranda¹, Madilyn Pardini², David Rosen¹, Colleen Reichmuth³
¹University of San Francisco, San Francisco, CA, ²University of California Santa Cruz, ³University of California, Santa Cruz, ⁴UBC Marine Mammal Research Unit, Vancouver, British Columbia, ⁵University of California Santa Cruz and Alaska SeaLife Center, Santa Cruz, California

Seals rely on thick blubber and peripheral blood flow regulation to maintain thermal homeostasis. During the annual molt, seals haul out for extended periods to increase blood flow to the skin, which provides essential nutrients and optimal temperatures for tissue regeneration, while limiting heat loss to the environment. Unfortunately, ongoing sea ice loss and associated reductions in haul-out substrate may force Arctic seals to move with retreating sea ice, use terrestrial haul-outs, or spend increasing amounts of time in water. The degree to which increased time in water may result in higher thermoregulatory costs depends on the level of vasocontrol during the molt period. We hypothesized that if seals maintain control of heat loss through selective skin perfusion during molt, then RMR should be similarly elevated when in water and hauled out. Alternatively, if molting seals have a reduced ability to regulate blood flow to the periphery, then RMR in water would be even higher than when hauled out.

Using open-flow respirometry, we measured the resting metabolic rate (RMR) of three spotted seals (Phoca largha), one ringed seal (Pusa hispida), and one bearded seal (Erignathus barbatus) prior to, during, and following the molting period while resting in water or hauled out. Individual and species comparisons confirmed that energetic costs incurred during molt were not higher for seals resting in water relative to when hauled out. These data suggest that seals maintain control of peripheral blood flow and heat loss, irrespective of molting status, with elevated RMR values during molt attributable to the energetic cost of tissue regeneration rather than unregulated skin perfusion. By combining these measurements with emerging data on haul-out behavior and thermal physiology surrounding the molt, we aim to elucidate how the loss of haul-out substrate and increased time in water may affect ice-dependent seals in the wild.

Synoptic assessment of common bottlenose dolphin (Tursiops truncatus) distribution in Tampa Bay and coastal Gulf of Mexico, Florida, using autonomous acoustic recorders
Cecilia Thompson¹, Peter Simard², Shannon Gowans³, David Mann⁴
¹Eckerd College, ²Eckerd College, St. Petersburg, FL, ³Eckerd College, St Petersburg, FL, ⁴Loggerhead Instruments, Inc., Sarasota, FL

Common bottlenose dolphins (Tursiops truncatus) produce a variety of sounds for social, navigation, and foraging purposes. These sounds can serve as a valuable tool in determining distribution and to infer behavior and habitat association. By deploying multiple autonomous acoustic recorders, researchers can reduce the spatial and temporal undersampling typical with visual surveys. This study presents a synoptic survey of bottlenose dolphin distribution in Tampa Bay and coastal Gulf of Mexico, Florida, using multiple autonomous acoustic recorders. Recordings collected in November 2011 and May 2012 from seven stations were analyzed: three located in Boca Ciega Bay (Tampa Bay habitat), three in passes between Boca Ciega Bay and the Gulf of Mexico (Pass habitat), and one in the open Gulf of Mexico (Gulf habitat). Dolphin sounds were manually identified, and sound production rates (sounds/hour/km²) were
calculated using an algorithm that accounts for transmission loss and ambient noise. Preliminary results indicated that significantly higher echolocation detection rates occurred in the Pass habitats in the winter than summer (based on Welch’s ANOVA and Tukey post-hoc tests), supporting previous studies that suggest higher use of passes by bottlenose dolphins in winter months, and that the passes are important foraging areas at this time of year. Echolocation rates were also higher in the Pass habitat than in either the Bay or Gulf habitats, suggesting that passes were overall an important habitat for foraging. Full analysis will investigate variation in whistle, burst pulse and low frequency narrow band (LFN) rates as well as sound detection rates in relation to water temperature. This study provides a greater understanding of bottlenose dolphin distribution and behavior. Additionally, due to increasing anthropogenic disturbance within the marine environment of Tampa Bay, our results will be valuable in identifying high-use areas for conservation and management purposes.

An Advancement in Rotational Equivariant Representations for Photographic Identification of Individuals using Fourier Harmonic Neural Networks.
Jaime Thompson¹, Qian Yang¹, Weiyun You¹
¹Valdez AI Consulting

Photographic identification is an essential research and management tool for marine mammal scientists. However, manual identification of individuals is time-consuming. Even with computer assisted methods, identification of individuals using images is computationally intensive and struggles with recognizing individuals from subtle differences in natural markings such as stripes or rosettes due to the large amount of variance in the embedding space introduced form even small changes in orientation and perspective. To this end, we propose a novel neural architecture which addresses this limitation by using complex valued convolutions based on radial Fourier harmonics. In the same way that the typical Fourier decomposition of a signal enjoys translational invariance, applying the analogous transform in a radial coordinate basis enjoys rotational invariance. This alleviates the need for using larger neural networks to overcome the changes in orientation and perspective as well as the heavy reliance on orientation based data augmentations. We demonstrate that this increase in efficiency allows us to create a lightweight neural network application called markFindR capable of addressing challenging recognition task on typical laptop hardware using whale-sharks (Rhincodon typus) as an example target species.

Preliminary Use of Blow Proteomics to Investigate Dive Physiology and Immune Responses
Laura Thompson¹, Benjamin Neely², Lauryn Yates³, Tracy Romano⁴
¹Mystic Aquarium, Mystic, Connecticut, ²National Institute of Standards and Technology, Charleston, SC, ³University of Alaska, Anchorage, ⁴Mystic Aquarium, Mystic, CT

Collection of blow condensate has gained traction as a non-invasive alternative to blood for monitoring cetacean health and physiological status. Previously, preliminary data was presented including the proteomic profile of beluga blow, and dive-related abundance changes for the top 150 most abundant proteins. In this study, patterns of change in blow proteins involved in immune function, complement and inflammation, coagulation and hypoxia in a beluga (Delphinapterus leucas) following diving are investigated. Blow samples were collected from a single beluga whale trained to perform either stationary dives to a single target, or active submerged swimming for a duration of 3.5 minutes. Blow samples from two stationary and two active dives were analyzed using data-
independent acquisition shotgun proteomics, and individual proteins were then broadly categorized as complement, coagulation, hypoxia and immune function. Because only two trials for each dive type were analyzed, no statistical analyses could be run and few clear distinctions between stationary and active dives were observable. However, a few patterns in protein abundance stood out. Namely, the first stationary dive trial (stationary1) appeared to be the most different from each of the 3 other dives: increased abundance of complement proteins was detected following stationary1, while decreased abundance was detected following all other dives. This pattern was also observed for proteins involved in coagulation and hypoxia responses. A potential reason for this difference is currently being explored. There were a few exceptions to this pattern. Annexin A5, an anticoagulant, increased in abundance following both stationary dives, while decreased abundance was observed following active dives. Other individual proteins which differed between active and stationary dives include Creatine Kinase and HLA Class II Histocompatibility Antigen Beta Chain-1. Further development of this research is underway, including increasing sample size and replicates, as well as increasing dive durations.

How does operational offshore wind farm sound affect marine mammals?

Frank Thomsen¹, Uwe Stöber²
¹DHI, Hørsholm, Denmark, ²DHI-Wasy, Berlin, Berlin, Germany

With the transition to green energy production there is an increasing demand for offshore wind energy involving an increasing number of wind farms with increasingly larger turbine sizes. While the impacts of underwater sound related to offshore wind farm construction have been studied in detail, the impacts from operational sound are generally considered negligible due to relatively low emissions. Yet, turbines are getting larger and so do the emitted sound fields and as operational noise is permanent, there is an urgent need to investigate its risk to affect behaviour and hearing in marine mammals. Here, both broadband sound levels and specific 1/3 octave band levels associated with existing wind turbines were extrapolated to a fictive 10 MW wind turbine based on nominal turbine powers. The estimated source level of such a turbine was 167 dB re 1 µPa at 1m. Using U.S regulatory noise criteria for behavioral disruption for continuous noise, a behavioral response in marine mammals would be expected for up to 1.4 km distance from the turbine. Although, this avoidance zone is relatively small, impact areas from different turbines in a wind farm will likely overlap and could lead to temporary or even permanent displacement from the entire offshore wind farm habitat. Conversely, if animals chose to stay or return to the area, there is the possibility for hearing impairment if exposure happens for extended periods. In any case, the potential effects of operational noise on marine mammals should be considered in environmental risk assessments.

A Programmatic Approach to Endangered Species Act Section 7 Consultation on Permitting Cetacean Research and Enhancement Activities

Howard Goldstein¹, Steven Thornton², Greg Fulling³, Shasta McClenahan⁴, Amy Hapeman⁵, Carrie Hubard⁶
¹National Marine Fisheries Service, Silver Spring, Maryland, ²NOAA, Norfolk, Virginia, ³National Marine Fisheries Service, Silver Spring, MD, ⁴NOAA, Silver Spring, MD, ⁵NOAA, ⁶NOAA Fisheries

Under Section 7(a)(2) of the Endangered Species Act (ESA), federal agencies are required to consult with the National Marine Fisheries Service (NMFS) when an action the agencies may take (defined as funding, authorizing, or carrying out) may result in effects to ESA-listed species or designated critical habitat. If a
proposed action may have adverse effects, a formal consultation is required under ESA Section 7(a)(2). In September 2018, the NMFS Permits and Conservation Division requested formal programmatic ESA section 7 consultation on its permitting program for cetacean research and enhancement activities in the Arctic, Atlantic, Indian, Pacific, and Southern Oceans because of the potential effects of the program on threatened and endangered species and designated critical habitat under NMFS' jurisdiction. As part of the consultation, NMFS established a programmatic framework for permitting the majority of methods commonly used for cetacean research and certain enhancement activities, as well as opportunistic research on and unintentional effects to ESA-listed pinnipeds. The framework includes mitigation for and limits on certain invasive procedures, established permit application cycles, and standardizes reporting schedules and information. Benefits of this programmatic consultation framework include: (1) enhancing species conservation, recovery, and management; (2) facilitating the cumulative assessment of impacts from these activities to ensure effects are minimized; (3) streamlining the permit processing time to six months; (4) creating efficiency by consolidating section 7 consultations for individual permits into one programmatic process; and (5) allowing adaptive management in permitting certain invasive procedures. We describe here the cetacean programmatic consultation framework including activities covered, the permit application process, and reporting information. We also evaluate the reduction in processing time and number of section 7 consultations needed.

Southern Resident Killer Whale (Orcinus orca) fine scale habitat use patterns reveal conflict zones with vessel presence in northeast Pacific waters
Sheila J. Thornton¹, Scott Toews², Eva Stredulinsky³, Katherine Gavrilchuk⁴, Christine Konrad Clarke⁵, Pramod Thupaki⁶, Rianna Burnham⁷, Svein Vagle⁸
¹DFO - Fisheries and Oceans Canada, West Vancouver, British Columbia, ²Fisheries and Oceans Canada, Vancouver, British Columbia, ³Fisheries and Oceans Canada, Nanaimo, ⁴Fisheries and Oceans Canada, West Vancouver, ⁵Fisheries and Oceans Canada, Sidney, British Columbia, ⁶Fisheries and Oceans Canada, Victoria, British Columbia, ⁷Fisheries and Oceans Canada, Sidney

The Southern Resident Killer Whale (SRKW; Orcinus orca) population in Canadian Pacific waters is listed as Endangered under the Species at Risk Act. Critical habitat (CH) has been identified for this population and includes the waters on the continental shelf off southwestern Vancouver Island and eastward to the inner waters of the Salish Sea. While SRKW are known to spend a large proportion of the year in their CH, which constitutes a small portion of their overall range, information on finer scale occurrence and habitat use patterns within CH is lacking. Here, we used a novel modelling approach on sightings data from 2009-2020 to visualise monthly intensity of occurrence of SRKW within CH for May to October. The model allowed unification of data sets collected using differing sampling methods. We also conducted behavioural surveys to evaluate habitat use and identify key areas of foraging and travel. Evaluation of acoustic detections from passive acoustic recorders deployed in SRKW CH provided further data on presence, residency, and habitat use, and strengthened the interpretation of sightings data. These results highlight the importance of the waters around Swiftsure Bank and the eastern portion of Haro Strait from May to October for SRKW. The behavioural analyses identified areas of foraging associated with these high-use areas. These areas of high use are transected by international shipping lanes and are subject to varying levels of recreational vessel traffic, leading to concerns
over impacts from acoustic and physical disturbance. Decreased foraging success and altered calling behaviours are noted responses by SRKW to vessel presence and have potential impacts on energetics. As the population is small and exhibits signs of nutritional stress, efforts to decrease potential impacts to foraging are paramount for recovery of the population.

Seasonal distribution patterns of the leopard seal (Hydrurga leptonyx) in the Wilhelm Archipelago area (West Antarctic Peninsula) in 2021

Vadym Tkachenko1, Oksana Savenko2
1National Antarctic Scientific Center of Ukraine, Melitopol, Zaporozhye, Ukraine, 2National Antarctic Scientific Center / Ukrainian Scientific Center of Ecology of the Sea, Odesa, Ukraine

The West Antarctic Peninsula (WAP) region is experiencing one of the fastest rates of climate change on Earth. Leopard seal (LS) is an important Antarctic apex predator. This pagophilic species is very sensitive to the changing conditions of the ecosystem. LS uses waters of the WAP during the whole year. But most of the research is carried out in summer. Our goal was to monitor the LS presence in the Wilhelm Archipelago area during the late autumn, winter, and spring: from April to December 2021. The boat-based and coast-based monitoring was conducted at the Ukrainian Antarctic Akademik Vernadsky Station (Galindez Island, Argentine Islands). The main study locations were waters of the Wilhelm Archipelago and its adjacent area, including Penola Strait and French Passage. The 69 boat surveys of the 1052 nautical miles were conducted. In total, 43 LS were sighted, 27 by the boat surveys, and 16 from the shore. The encounter rates were distributed almost evenly between different seasons. All LS were sighted as single individuals, 26 on the ice, and 17 in the water. The main sightings locations were close to the Pygoscelis penguin’s colonies: Galindez, Petermann, and Pléneau Islands. We sighted LS of both sexes, and only 3 individuals were juvenile. Multiple foraging events were observed. The main feeding sources were gentoo penguins (Pygoscelis papua) and the Antarctic krill (Euphausia superba). A total of 14 individuals of the LS were photo-identified during the survey using natural markers such as pigmentation patterns of the head and body. The first results of our year-round long-term monitoring show the ability to monitor LS in changing conditions of the WAP. As a part of the complex monitoring program, passive acoustic monitoring should be also performed to better understand seasonal distribution patterns and ecology of the LS in the area.

Extracting foraging behavior from passive acoustic monitoring data to better understand harbor porpoise (Phocoena phocoena) foraging habitat use.

Nicole Todd1, Mark Jessopp, Emer Rogan2, Ailbhe, Sarah Kavanagh3
1University College Cork, Cork, Cork, Ireland, 2University College Cork, Cork, Ireland, 3University College Cork, Ringaskiddy, Co. Cork, Ireland

Understanding the distribution of marine mammals is important for effective conservation through designation of protected areas. However, most approaches to monitoring often fail to differentiate between areas used for important activities such as breeding, feeding, or resting, which may undermine conservation objectives. For echolocating cetacean species, passive acoustic monitoring can be used to differentiate between general ‘occurrence’ in an area, and feeding activity. This is achieved through classification of feeding buzzes, where prior to a prey capture attempt the rate of echolocation clicks drastically increases. We use a nine-year acoustic dataset from northwest Ireland and a generalised additive modelling approach to examine the spatiotemporal distribution of
harbour porpoise (*Phocoena phocoena*) foraging behaviour at a range of temporal scales. Within periods when harbour porpoise were detected in the area, complex interannual and seasonal variation was found. More intensive foraging activity occurred in autumn and winter, and varied over the diel cycle with a strong preference for nocturnal foraging. The foraging intensity of harbour porpoise was positively influenced by the co-occurrence of dolphins, and negatively affected by the presence of construction activity. In contrast to previous studies, tidal state did not have an effect on foraging activity across our time-series. The study highlights the value of using a long acoustic time-series, showing that harbour porpoise foraging behaviour is likely site specific and more complex than previously understood. This approach, if utilised on a larger spatial scale has the potential to identify foraging hotspots for a range of odontocete species, which would better inform marine spatial planning.

Dive into the blow microbiome of free-ranging short-finned pilot whales: protocol optimization and preliminary results.

Maria Paola Tomasino
t Beatriz Santos Silva
t Filipe Alves
t Ana Dinis
t Rita Ferreira
t Mafalda Correia
t Raul Valente
t AGATHA GIL
t Filipe Castro
t Isabel Sousa-Pinto
t Massimiliano Rosso
t Cinzia Centelleghe
t Sandro Mazzariol
t Catarina Magalhaes

1CIIMAR - Interdisciplinary Centre of Marine and Environmental Research VAT: PT508792657. LO#258635, Matosinhos, Portugal, 2CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, 3MARE - Marine and Environmental Sciences Centre, Portugal, 4MARE/ARDITI/OOM, Funchal, Portugal, 5MARE-Madeira, Portugal, 6VAT# PT501413197 Universidade do Porto - Faculdade de Ciências, Porto, Portugal, 7FCUP - Faculty of Sciences, University of Porto, CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, Porto, Portugal,

The emerging field of cetacean microbiology has recently shed light on the exhaled breath condensate (EBC), or ‘blow’, as a suitable matrix to discover the microbial communities within their respiratory tract. The identification of potential bacterial and viral pathogens in the EBCs represents a promising non-invasive tool for cetacean health assessment. Although culture-dependent and -independent studies contribute in providing a more comprehensive characterization of the microbial blow community, knowledge of the cetaceans’ respiratory microbiome remains largely unknown, including for short-finned pilot whales (*Globicephala macrorhynchus*). The aim of this study was to develop a sampling/analysis protocol for the characterization of the microbial diversity in the EBC of free-ranging short-finned pilot whales, and in the surrounding seawater. Our methodology involved 28 blow samples and 22 seawater control samples collected in the waters of Madeira Island (Portugal) in 2018 and 2019. Two different sampling methodologies were tested (direct blow pipetting vs. collection with swab). DNA was isolated and amplicon sequencing was performed using Illumina MiSeq platform, targeting two different (V3–V4 and V4–V5) hypervariable regions of the 16S rRNA gene. DADA2 bioinformatic pipeline was used to process sequences. Preliminary results indicate different microbial community structures of blow microbiome and seawater. The latter harbors more diversity while the EBC was mainly composed of two major phyla: Proteobacteria and Bacteroidetes. Further in-depth taxonomic analyses will show commonalities and differences between EBCs,
highlighting potential pathogens. A comprehensive comparison of the primer sets performance (regarding amplification and taxa coverage) will be useful to select the most suitable primer sets for blow and seawater. Besides the development of an optimized protocol for blow sampling and microbiome analysis, this work provides a network of consistent core taxa from the EBC short-finned pilot whale microbiome. It will serve as an innovative non-invasive methodology for cetacean health monitoring.

**Automatic Detection of Large Cetaceans Day or Night from Long-Wave-Infrared Video using Machine Learning Algorithms**

Christina Tombach Wright¹, Jon Waltman², Kochise Bennett³, Kevin Sullivan³

¹Toyon Research Corporation, Santa Barbara, California, ²Toyon Research Corporation, Goleta, CA, ³Toyon Research Corporation, Goleta, CA

Deep neural networks and machine learning techniques have rapidly advanced the field of target identification, classification, and tracking. Applying new technologies to marine mammal science allows for automation of both the data collection and the data processing components of the research. Marine mammals, particularly cetaceans, spend most of their time under water making them difficult research subjects. Typically, these animals are studied visually and/or acoustically, but visual observations can only be made by human observers during daylight hours. Advancements in thermal imaging technologies have made infrared cameras and scopes commercially available to researchers, providing the opportunity for visual observations to be conducted during nighttime hours. Employing round-the-clock human observers for research or mitigation can be logistically challenging and costly. Long-wave-infrared (LWIR) cameras have been used in recent studies (Sullivan, *et al.*, 2020; Zittarbart, *et al.*, 2020) to automatically detect marine mammals during the day or night. Manually processing the hours, days, or weeks of resulting video is cumbersome and expensive. Toyon Research Corporation developed a Whale Spout Detector (WSD) algorithm that automatically detects large cetacean spouts (blows) from real-time and/or recorded LWIR video. While previously demonstrated algorithms can successfully detect large whale blows from video, the false-alarm rate can burden human analysts when trying to verify results. Using an advanced neural network version of the WSD software to process the same LWIR video data resulted in a probability of detection (pd) that approximated that of original auto-detect algorithms and produced a rate of false alarms that was orders of magnitude lower. A low rate of false positives allows for quality control and human verification of even very large datasets. The software we developed is easy to use and has a broad applicability for detecting marine mammals from shore, ship, and air.

**What is ‘residency’? A systematic mapping approach to reviewing the residency construct with focus on odontocetes**

Christina Toms¹, Katherine McHugh¹, Reny Tyson Moore², Josephine Slaathaug³, Randall Wells¹

¹Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, Florida, ²Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, FL, ³Northeastern University, Boston, Massachusetts

Residency and site fidelity patterns have been described for numerous species of cetaceans worldwide but assessing residency in cetaceans is not a straightforward process. Studies are often constrained by time and resources available, ease of access to the targeted study area, and availability of the target species. As such, operational definitions, assessment strategies, and measures have varied widely, and
quantitative metrics are uncommon. To date, there is no unifying conceptual approach to defining and assessing residency, begging the question - how does one adequately quantify residency in a biologically meaningful way? To address that, one must also ask – what exactly is ‘residency’? Discussion of residency in the literature can be found in terms of long-term occupancy, philopatry to a natal home range, and site fidelity, but each of these terms and measures come with additional variants in conceptual and operational definitions, and terminologies can be used interchangeably. The purpose of this study is to determine the extent to which development of a unifying conceptual approach to evaluating residency is possible. We take a systematic mapping approach to synthesize information from existing publications that seek to assess, describe, and/or characterize residency and/or site fidelity patterns in odontocetes. 2,834 abstracts and 1,163 full texts were screened for relevant literature. The resulting extracted data were used to clarify the conceptual framework of ‘residency’, summarize the breadth of how it has been applied in the odontocete literature, and identify trends and inconsistencies in how residency and related terms are used and defined. While a universal approach to assessing residency is likely to prove impractical, we recognize the potential benefits of a consensus for the conceptualization, as it directly relates to defining appropriate management units and estimating demographic parameters for groups of animals at the appropriate scale.

Effect of boat presence on short-beaked common dolphin (Delphinus delphis) and common bottlenose dolphin (Tursiops truncatus) in Algarve, Portugal
Michal Topczewski1, André Cid2, Alicia Quirin3, Joana Castro4
1Business Academy Aarhus, AIMM - Marine Environment Research Association, Aarhus N, Jutland, Denmark, 2AIMM, Lisboa, Portugal, 3AIMM, Portugal, Portugal

The whale-watching industry expanded drastically over the last few decades and is continuously growing worldwide. This study analysed how common dolphins (Delphinus delphis) and bottlenose dolphins (Tursiops truncatus) respond towards approaching boats, depending on the number of boats present in their proximity. The behavioural responses were categorised as approach, indifferent and evasive. Changes in response were also analysed based on a temporal scale and differences between the targeted species were addressed. Data used for this research were collected from 2010 to 2020, in the region of Albufeira, Portugal. Our results show that for both species the approach response decreased and the evasive response increased as the number of boats grew, indicating that a higher number of boats present is more likely to disturb the dolphins. Approachability decreased significantly when there were three or more boats present in the proximity, which coincides with the local regulations allowing the presence of a maximum of three boats within a 100-meter radius from the cetaceans. During the 10 years of study, the approach response followed a decreasing trend, which might suggest a long-term negative impact of the whale-watching activity on cetaceans within the region. When comparing both species, common dolphins were significantly more likely to display approaching behaviour ($P = 0.049$), whereas bottlenose dolphins showed significantly more indifferent responses ($P < 0.001$). During sightings of higher pressure (six or more boats), bottlenose dolphins were overall more indifferent and less evasive than common dolphins, suggesting that they are potentially more resistant to higher levels of disturbance. Based on these findings, it is recommended that whale-watching companies comply with the local legal limits of three boats present during a sighting to limit their
disturbance on the animals. This would also be advantageous for the whale-watching companies, as approaching animals are more attractive for the customers.

Heavy faeces: Cadmium in the Juan Fernández fur seal
Constanza Toro Valdivieso¹, Barbara Blacklaws², Ravin Ravin Jugdaohsingh², Jaume Forcada¹, Joe Hoffman¹, Jonathan Powell¹
¹University of Cambridge, ²University of Cambridge, Cambridge, United Kingdom, ³British Antarctic Survey, Cambridge, ⁴Bielefeld, Germany

Faecal samples were used to evaluate the cadmium (Cd) exposure of two fur seals species; the Juan Fernandez fur seal (JFFS) and the Antarctic fur seal (ANFS). Concentrations of Cd were substantially and significantly higher in JFFS faeces (AN mean: 0.43 ± 0.29 0.56 µg g⁻¹ ww, JFFS mean: 61.7 ± 74.5 0.56 µg g⁻¹ ww, W = 0, p < 0.001). Differences in exposure are likely to be explained by diet. Previous reports showed that krill is the most important ANFS summer prey while JFFS would feed mostly on myctophids and cephalopods such as squid and octopus. High Cd concentrations were also found in the hepatopancreas from three different octopus specimens collected in the Juan Fernandez archipelago (JF). Despite having insufficient samples to perform statistical inference, cephalopods are known for accumulating heavy metals, which can then be passed to their predators; thus, it is likely that a diet rich in cephalopods could explain the Cd exposure in JFFS. Finally, Inductively coupled plasma mass spectrometry (ICP-MS) was again used to analyse the Cd concentrations in JFFS bones. Once more, high levels of Cd were found in the JFFS bone samples (adults mean 0.56 ± 0.41 µg g⁻¹ ww, pups mean 0.18 ± 0.11 µg g⁻¹ ww), evidencing Cd absorption and accumulation of this metal. Cd concentration in pups bones suggested Cd transfer through milk. As a first insight into the JFFS Heavy exposure since the early 90s, this study evidenced a high Cd exposure, absorption and accumulation in the little-studied JFFS, an endemic marine mammal to the isolated Juan Fernandez archipelago. More research will be needed to understand the contamination effects and possible adaptation the species might have developed. This research is an important contribution to the conservation of JFFS, food security and human health.

Are Mothers with Newborn Calves Continuing their Migration? GPS Track Movements from Gold Coast Bay, Australia.
Laura Torre-Williams¹, Jan-Olaf Meynecke², Emmanuelle Martinez³
¹Griffith University, Auckland, New Zealand, ²Griffith University, Australia, ³Applied and Environmental Sciences Department, NorthTec, Whangārei, New Zealand

Southern Hemisphere humpback whales (Megaptera novaeangliae) migrate annually from their Antarctic feeding grounds to warmer waters during winter to find suitable calving habitats, which include warm (19-28°C), shallow (less than 50m), and sheltered waters. East Australian humpback whales (E1) are thought to breed within the vast Great Barrier Reef region (16°S to 24°S). However, there are confirmed records of newborn humpback whale calves to the south of the main breeding area including in areas such as the Gold Coast Bay (28°S). This bay provides suitable calving habitat for the recovering E1 population and newborn calves have been documented there since 2013 between June and September. We investigated the direction of travel for mother humpback whale and newborn calf pairs sighted in the Gold Coast Bay from 2013 to 2018. More specifically, we (1) recorded focal pair GPS tracks from whale-watch vessels in close proximity (over 100m) to mother and newborn calf pairs, and (2) assigned relative age classification of newborn calves based on key
diagnostic morphological features. Results indicated that the majority of E1 humpback whale mother and newborn calf pairs travelled in a northward direction through the Gold Coast Bay. We conclude that mother humpback whales giving birth south of the primary breeding area may continue their migration to the north after parturition. These findings may signify that mother whales continue to seek warm waters for the earliest stages of the calf’s development. Mother humpback whales are known to pass on cultural memory and thus may instinctually be driven to the northern waters. Newborn humpback whale calves are poorly studied in the wild and are thought to have very limited swimming capability in the earliest life stages. Understanding how newborn humpback whale calves utilise coastal waters is important to inform future conservation management decisions.

Range-wide comparison of gray whale body condition and prey quality reveals contrasting sub-population health characteristics and vulnerability to environmental change

Leigh Torres¹, Clara Bird², KC Bierlich³, Fredrik Christiansen⁴, Lars Bejder⁵, Jorge Urban⁶, Fabian Rodríguez-González⁷, Leila Lemos⁸, Amy Willoughby⁹, Lisa Hildebrand¹⁰

¹Marine Mammal Institute, Oregon State University, Newport, Oregon, ²Marine Mammal Institute, Oregon State University, Royal Oak, MI, ³Marine Mammal Institute, Oregon State University, ⁴Aarhus Institute of Advanced Studies, Aarhus, Denmark, ⁵Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, Hawaii, HI, ⁶Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico, ⁷Departamento de Ciencias Marinas y Coseras, La Paz, B.C.S, Mexico, ⁸Florida International University, Brazil, ⁹Joint Institute for the Study of the Atmosphere and Ocean, Alaska Fisheries Science Center NOAA, Seattle, WA

A rise in stranded, emaciated eastern North Pacific (ENP) gray whales was declared an unusual mortality event (UME) in 2019. Within the larger ENP population (~25,000 individuals), which primarily forage in the Arctic on benthic amphipods, is a sub-group called the Pacific Coast Feeding Group (PCFG; ~250). The PCFG forages on epibenthic zooplankton in coastal habitats between northern California, USA and British Columbia, Canada. Bomb calorimetry revealed two common PCFG prey species have higher caloric values than the predominant Arctic prey. To determine if the ENP and PCFG populations responded differently to the UME, body condition was compared through drone photogrammetry collected during four years (2017-2020) of PCFG gray whales on their foraging grounds in Oregon, USA (n=129) and gray whales on their breeding grounds in Baja, Mexico (n=298). This analysis revealed (1) whales in Baja were in better body condition than Oregon PCFG whales; (2) concurrently, body condition improved in PCFG whales, while declining in Baja whales; (3) the mean body condition did not change during migration. From these findings we hypothesize that (1) the Baja dataset is mainly composed of ENP whales and few PCFG whales, (2) the UME is primarily impacting ENP whales, (3) PCFG whales typically have lower body condition compared to ENP whales, and (4) energetic costs of migration for gray whales are overall low. Photogrammetry analysis of opportunistic aerial images of Arctic gray whales (n=18) supports hypothesis 3: body condition of PCFG whales (n=30) was significantly lower (p=0.01) despite having similar lengths. Synthesized, ENP whales appear to be suffering from reduced Arctic prey availability, while PCFG whales are recovering from poor prey conditions during the “warm blob” event of 2014-2016. Each group balances different energetic tradeoffs, while responding to different environmental forces on their foraging grounds, to ensure sufficient mass gain for population viability.
Ontogeny of echolocation in bottlenose dolphins (Tursiops spp.)

Sara Torres Ortiz1, Freja Jakobsen2, Javier Almunia2, Auguste von Bayern3, Lars Bejder4, Lara Delgado-García5, Vincent Janik6, Chloé Malinka7, Janet Mann8, Kerstin Ternes9, Magnus Wahlberg10, Thomas Goetz11

1Max-Planck-Institute for Ornithology, Puerto de la Cruz, Santa Cruz de Tenerife, Spain, 2Freja Jakobsen, Odense C, Denmark, 3Max-Planck-Institute for Ornithology, Seewiesen, Germany, 4Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, Hawaii, HI, 5University of Southern Denmark, Barcelona, Spain, 6University of St Andrews, St Andrews, Fife, United Kingdom, 7Marine Bioacoustics Lab, Dept. Bioscience, Aarhus University, Aarhus, Denmark, 8Georgetown University, Washington, DC, 9Duisburg Zoo, Duisburg, Duisburg, Germany, 10Marine Biological Research Centre, University of Southern Denmark, Kerteminde, Funen, Denmark, 11Sea Mammal Research Unit, St Andrews, United Kingdom

Dolphins’ exquisite echolocation abilities require elaborate acoustic neural processing skills and constitute a major sensory window for learning about the world. Little is known about how echolocation develops in newborns. We regularly recorded sound and behaviour of neonate bottlenose dolphins (Tursiops truncatus and Tursiops aduncus) during the first weeks after birth, for animals born both under human care and in the wild. Recordings with acoustic data loggers and hydrophone arrays, in synchrony with video observations gave detailed behavioural and acoustic data from mothers and calves. We found that dolphin neonates are born with the ability to produce echolocation clicks, and that clicks obtain the spectral and temporal structure of adults within the first three weeks post-partum. The range-dependent modulation of source level and inter-click intervals found in adult dolphin biosonar seems to develop in calves already a few weeks post-partum. The rapid development of echolocation abilities strongly indicates that sensory input from biosonar can be used by neonate dolphins at a very young age.

Elephant seal muscle cells adapt to sustained glucocorticoid exposure by shifting their metabolic phenotype

Julia Maria Torres-Velarde1, Sree Rohit Raj Kolora1, Jane Khudyakov2, Daniel Crocker3, Peter Sudmant4, Jose Pablo Vazquez-Medina5

1University of California, Berkeley, Torreon, Coahuila, Mexico, 2Department of Biological Sciences, University of the Pacific, Stockton, California, 3Sonoma State University, Rohnert Park, CA, 4UC Berkeley, 5University of California, Berkeley, Berkeley, California

Elephant seals experience natural periods of prolonged food deprivation while breeding, molting, and undergoing postnatal development. Prolonged food deprivation in elephant seals increases circulating glucocorticoids without inducing muscle atrophy, but the cellular mechanisms that allow elephant seals to cope with such conditions remain elusive. We generated a cellular model and conducted transcriptomic, metabolic, and morphological analyses to study how seal cells adapt to sustained glucocorticoid exposure. Seal muscle progenitor cells differentiate into contractile myotubes with a distinctive morphology, gene expression profile, and metabolic phenotype. Exposure to dexamethasone at three ascending concentrations for 48h modulated the expression of 6 clusters of genes related to structural constituents of muscle and pathways associated with energy metabolism and cell survival. Knockdown of the glucocorticoid receptor (GR) and downstream expression analyses corroborated that GR mediates the observed effects. Dexamethasone also decreased cellular respiration, shifted the metabolic phenotype towards glycolysis, and induced mitochondrial
fission and dissociation of mitochondria-ER interactions without decreasing cell viability. Knockdown of DDIT4, a GR target involved in the dissociation of mitochondria-ER membranes, recovered respiration and modulated antioxidant gene expression. These results show that adaptation to sustained glucocorticoid exposure in elephant seal myotubes involves a metabolic shift toward glycolysis, which is supported by alterations in mitochondrial morphology and a reduction in mitochondria-ER interactions, resulting in decreased respiration without compromising cell survival.

Calling from nowhere: Assessing marine mammal diversity around St Paul and Amsterdam Islands (Indian Ocean) using an acoustic glider, as a groundwork for the French Southern Lands nature reserve extension
Maëlle Torterotot¹, Julie Beesau², Flore Samaran³
¹ENSTA Bretagne, Brest, Bretagne, France, ²ENSTA Bretagne, Brest, France, ³ENSTA Bretagne

The marine territories surrounding the French sub-antarctic islands are known to be exceptional biodiversity hotspots. Although the size of the French Southern Lands nature reserve covers about 45% to 70% of the EEZ in Crozet and Kerguelen islands, this number only reaches 4% in St Paul and Amsterdam islands. So far, the lack of knowledge has been the main obstacle to a wider extension of the MPA in these waters. In this context, we deployed an autonomous acoustic glider around St Paul and Amsterdam islands to continuously monitor the soundscape (sampling frequency of 48kHz) from February 28 to April 5 2019. The glider started its route north of St Paul island, went south toward a sea mount and then back and around St Paul island before gliding towards and around Amsterdam island twice. Acoustic data were manually visualized for marine mammal presence over three frequency bandwidths (0-480 Hz, 0-2kHz, 0-24kHz) to encompass the full spectra. Marine mammal acoustic contacts occurred in more than 75% of 10-minute time windows. We detected at least three blue whale acoustic population’s songs, spot or P-call (an unattributed baleen whale call), as well as some D-calls. Regarding odontocetes, sperm whales’ clicks and blackfish vocalizations were highly present in the dataset. Finally, we detected calls from a few other species that we will describe in the presentation. We will then expose the spatio-temporal occurrence of these marine mammal calls and sum it all up to present an acoustic diversity metric along the glider route. This work has shown that the St Paul and Amsterdam island waters are a habitat for numerous baleen and toothed whales. Combined with other scientific programs on pelagic and oceanographic features in this area, it will serve as a canvas for the delineation of the French Southern Lands nature reserve boundaries extension.

Potential impacts of wind farm operations on population dynamics and food habits of the common harbor seal (Phoca vitulina) in southern New Jersey
Jacalyn Toth Sullivan, Stockton University, Galloway, NJ

As the installation, operation, and maintenance of offshore wind farms becomes a consistent variable in the northeastern United States, questions remain regarding the level of impact these practices have on proximate marine mammal populations. In southern New Jersey (USA), plans for the installation of an 1,100 MW wind farm are underway (Orsted), with a target operation date of 2025. This proposed wind farm lease area sits 15-miles offshore of Atlantic City and is adjacent to New Jersey’s largest haul-out site for the common harbor seal (Phoca vitulina) within Great Bay, NJ. Beginning in Fall 2021, the occurrence, sighting patterns, haul-out behavior, and food habits of this seasonal harbor...
seal population (October - April) will be monitored as this offshore wind project proceeds. Goals of the study include determination of temporal patterns of harbor seal habitat use in Great Bay, population size, prey species, and shifts therein over time as this nearby wind farm becomes operational. Survey methods including harbor seal haul-out behavior monitoring, prey item hard parts analysis (via harbor seal scat), and DNA metabarcoding will be outlined and discussed. Preliminary project progress, along with results from previous population and diet studies on this same harbor seal population (1995-2011), will be summarized. As apex predators, harbor seals are an excellent indicator species for ecosystem shifts; population and food habits analysis will provide the opportunity to observe and inform on important biological processes of these animals during various phases of the neighboring offshore wind farm completion.

Spatiotemporal trends in bottlenose dolphin foraging behavior and relationship to environmental variables in a highly urbanized estuary
Sarah Trabue¹, Howard Rosenbaum², Melinda Rekdahl³, Carissa King⁴, Stephanie Adamczak⁵, Samantha Strindberg⁶


Marine predator foraging influences community structure and ecosystem functions, which are all linked with environmental variables. Determining variables that are associated with foraging can facilitate the identification of important habitats, which is particularly important in heavily urbanized systems. In the New York–New Jersey Harbor Estuary, bottlenose dolphins (Tursiops truncatus) are exposed to various stressors, including vessel activity and forthcoming offshore wind development. Here, we used passive acoustic monitoring to identify foraging conditions for dolphins from April–October of 2018–2020. When foraging, dolphins produce a series of rapid clicks (‘foraging buzzes’) which can be used as a proxy for foraging activity. We analyzed the relationship between acoustic detections of dolphins and environmental variables using a generalized additive modeling framework. The variables week, sea surface temperature (SST), and chlorophyll a (chl a) concentration were significantly associated with foraging activity at seasonal timescales. Foraging increased with increasing SST and water levels, with the peak of foraging occurring in autumn. The relationship between chl a concentration and foraging was not straightforward and warrants further research. Diel foraging trends varied seasonally and annually. These results suggest that passive acoustic monitoring and environmental variables may be used to investigate marine mammal behavior and assess seasonal foraging habitat for marine predators within dynamic, heterogenous, and human-dominated environments. Baseline data on dolphin habitat use is vital given the continued expansion of anthropogenic activities and climate-driven shifts in oceanographic conditions that are occurring in this region.

Blubber metabolic gene expression, insulin sensitivity and lipolytic rate are related to tissue depth and moult status, but not in vitro phthalate exposure in juvenile grey seals
Alexandra Tranganida¹, Ailsa Hall², Holly Armstrong³, Simon Moss², Georges Scholl⁴, Gauthier Eppe⁵, Cathy Debier⁶, Kimberley Bennett⁷

¹University of St Andrews, Dundee, United Kingdom, ²Sea Mammal Research Unit, St. Andrews, United Kingdom, ³University of St Andrews, ⁴Center for Analytical Research and Technology (CART), Research Unit MolSys, Liege, Belgium, ⁵Center for Analytical Research
Grey seals (*Halichoerus grypus*) and other marine mammals, rely heavily on blubber for metabolic fuel during prolonged fasting, periods of increased energy expenditure and when food is limited. Environmental contaminants such as phthalates, a group of plasticisers, which can enter the marine environment and food chain through plastic pollution, can disrupt normal energy balance regulation through impacts on fat tissue development and function in mammals. The effects of phthalates on blubber function of marine mammals remains largely unknown. Here, we used an explant model to investigate short exposure effects of benzyl butyl phthalate (BBP) on the gene and protein expression of key components of energy regulation in fat from juvenile grey seals. Animals (n=7) were sampled twice: during the moult and after the moult was finished. Inner and outer blubber biopsy samples were incubated overnight in control or BBP-treated media. Phosphorylation of Akt, a key component of insulin signalling, was measured. Akt phosphorylation was activated by insulin. No significant difference in phosphorylation was observed between controls and BBP-treated samples. However, total Akt content was significantly higher in inner compared to outer tissue, suggesting higher insulin sensitivity in inner tissue. Overnight BBP exposure did not affect mRNA abundance of components of pathways involved in adipogenesis and lipogenesis (stearoyl-CoA desaturase (*SCD*), insulin induced gene 2 (*INSIG2*), peroxisome proliferator-activated receptor gamma (*PPARG*)), or adipokines (adiponectin and leptin) measured by qPCR. Adiponectin expression was higher in moulting compared to post moult animals, which could confer greater insulin sensitivity. Lipolytic rate increased from moulting to post moult animals. These findings facilitate our understanding of changes in energy balance regulation mechanisms in yearlings. Our data suggest low dose phthalates do not have short-term effects on blubber function in this vulnerable life history stage, but we cannot rule out possible impacts of chronic exposure or higher doses.

Changes in human-caused serious injury and mortality of North Atlantic right and Gulf of Maine humpback whales

Marisa Trego¹, Allison Henry², David Morin¹, Diane Borggaard³, Michael Asaro⁴
¹NOAA Fisheries, ²Northeast Fisheries Center National Oceanographic Administration, Woods Hole, ³Greater Atlantic Region, NOAA Fisheries, ⁴NOAA Fisheries Greater Atlantic Regional Fisheries Office, Gloucester, MA, ⁵NOAA Fisheries, Woods Hole, MA

Human activities pose a significant risk to marine wildlife in the Northwest Atlantic Ocean, particularly those related to fishing and vessel activity. North Atlantic right whales and Gulf of Maine humpback whales are frequently identified in entanglement and vessel strike incidents and these anthropogenic stressors are contributing to high levels of mortality, impeding population recovery, and reducing resilience to additional environmental stressors. Revisiting long-term datasets can provide valuable insight into how exposure to anthropogenic stressors has changed over time and prioritize areas for risk mitigation. We investigated changes in observed serious injury and mortality of 295 right and 750 humpback whales between two time periods: 2001 to 2009 and 2010 to 2018. For entanglements with known gear types, we was analyzed the association between gear type and injury severity. Entanglement was the primary known cause of observed serious injury and mortality for right and humpback whales for both time periods, followed by vessel strikes. Serious injury or mortality caused by vessel strikes increased by 2.5 for humpbacks whales and 1.2 for right whales. Serious injury and mortality...
caused by entanglement doubled for right whales between 2010 and 2018 compared to the previous 9 years and was 1.5 times higher in humpback whales. Observations of right whale entanglements increased significantly in Canada compared to the US (p = 0.0085), though the number of incidents also doubled. Surveillance in Canadian waters increased substantially in the later time period, which could have introduced a bias in detection rates. Of entanglements where gear type was identified, trap/pot gear was significantly more likely to result in a serious injury or mortality compared to netting for right whales (p = 0.03) but not for humpback whales (p = 0.35). Refining our understanding of factors contributing to human-caused mortality will improve the development of effective conservation measures.

Spatial and Temporal Analyses of Atlantic Common Bottlenose Dolphin (Tursiops truncatus) Vocalizations and Distribution Patterns in Charleston Harbor, South Carolina

Caroline Tribble¹, Alyssa Marian², Agnieszka Monczak³, Patricia Fair⁴, Joseph Ballenger⁵, Michael Kendrick⁶, Bill Roumillat⁶, Lindsey Transue¹, Jamileh Soueidan³, Hannah Baker⁷, Meghan Weinpress-Galipeau⁸, Brian Balmer⁹, Melissa Hughes¹, Eric Montie¹

¹College of Charleston, ²University of South Carolina Beaufort, Beaufort, SC, ³University of South Carolina Beaufort, ⁴Medical University of South Carolina, Charleston, SC, ⁵South Carolina Department of Natural Resources, Charleston, South Carolina, ⁶South Carolina Department of Natural Resources, ⁷South Carolina Aquarium, Charleston, SC, ⁸South Carolina Aquarium, Charleston, South Carolina, ⁹National Marine Mammal Foundation, Johns Island, SC

Common bottlenose dolphins (Tursiops truncatus) rely on a range of vocalizations for social interactions, navigating complex environments, and acquisition of prey. However, there is increasing evidence that anthropogenic noise may alter acoustic behavior. Long-term passive acoustic monitoring (PAM) of dolphin vocalizations coupled with visual surveys in the May River estuary, South Carolina since 2013 identified dolphin sighting abundance peaks in late summer, whereas vocalizations peaked in the winter. The May River is similar in habitat to Charleston Harbor; however, the harbor is a deep inlet that experiences higher levels of vessel traffic and noise. Charleston Harbor spatial analyses of historical photo-ID surveys from 2004 to 2009 identified multiple core use areas and seasonal shifts in dolphin sighting abundance. In this study, we used PAM, visual survey, and prey abundance data collected in Charleston Harbor from December 2017 to June 2019 to determine: i) how temporal, spatial, environmental, and anthropogenic factors influence the acoustic repertoire of dolphins and ii) how acoustic and visual detections correlate across space and time. Our results indicated that dolphin vocalizations displayed spatial variation in the harbor. Vocalizations peaked in the fall and winter months following drops in water temperature and a decrease in daylight hours. In the fall and winter, prey abundance decreased, which may suggest that dolphins are echolocating at higher rates to locate prey. Sightings abundance also varied spatially with highest abundance (N=272) and vocalizations (N=43,967) in the area around the South Carolina Aquarium, and lowest abundance (N=72) and vocalizations (N=10,979) in the upper Ashley River. Ongoing investigation of these multivariate interactions may provide insight into what is driving these vocalization and distribution patterns and whether anthropogenic noise or prey abundance play significant roles.

A New Cost of Living Index for Marine Mammals

Andrew W. Trites¹, Kate Colson², Jérôme Spitz³, David Rosen¹

¹UBC Marine Mammal Research Unit,
The “Cost of living” (CoL) is a proposed index to categorize the energetic lifestyles of animals. Differences in CoL can reflect underlying contributions of physiology, behavior, and foraging strategies. It is a potentially unifying way to classify organisms that is independent of phylogeny and body size—and is a means to better understand commonalities in life histories, physiologies, and conservation needs of marine mammals that have arisen through the co-evolution of predator-prey interactions.

Unfortunately, a simple method to determine CoL from data that are readily available for all species of marine mammals has been elusive. We developed a new CoL Index for marine mammals by calculating the relative costs and benefits they incur according to 1) the diet they consume, 2) the energy density of their diet, 3) the difficulty of acquiring prey, and their 4) diving and 5) swimming abilities. We scored each of these five variables from 0 to 3, and then tallied them to obtain a CoL Index for 42 species of well-studied marine mammals. We validated our CoL estimates with independent measures of muscle performance, and found that marine mammals cluster into three types of lifestyles corresponding to low, medium, and high CoLs that are independent of body mass and phylogeny. Marine mammals with low CoLs tended to feed on benthic, low mobility species, while those with high CoLs targeted fast moving, energetically-rich prey. Both low and high CoL species must consume significantly more prey to cover their energy requirements compared with those classified as medium CoL—and may be less able to adapt to environmental changes. The simple qualitative method we propose to calculate a CoL index can be applied to all species of marine mammals in the absence of detailed measurements to better understand the evolution, behavior, conservation, ecology, and physiology of marine mammals.

Automatic Photo-Identification of Cetaceans via Deep Learning
Cameron Trotter1, Per Berggren2, Nick Wright3, A. Stephen McGough4
1Newcastle University, Newcastle Upon Tyne, gb, 2Newcastle University, School of Natural and Environmental Sciences, United Kingdom, 3Newcastle University, Newcastle Upon Tyne, Tyne and Wear, United Kingdom, 4School of Computing, Newcastle University, Newcastle upon Tyne, Tyne and Wear, United Kingdom

Photo-identification (photo-id) surveys collect increasingly vast amounts of data. These surveys generally require researchers to manually process collected data into a photo-id catalogue with ever growing cost and effort, leading to a potential increase in mis-identification due to issues such as observer fatigue. Computerised photo-id aides are available, but many do not employ state-of-the-art technology and those that do are required to be trained on large amounts of data, which may not always be available for every catalogued individual. We present a new system enabling fully automatic photo-id, requiring as few as one training image of each individual to allow for re-identification. The system takes in raw photographic data, no pre-processing is required. First the system detects and extracts each unique fin present in an input image (mAP@IOU[0.5, 0.75] = [0.96, 0.83]), which are then automatically cleaned and post-processed via morphological transformations, ensuring all relevant areas of the image are extracted and increasing the chance of identification. Next, the post-processed fins are passed through a Siamese Neural Network (SNN) to create an embedding, a low dimensional representation of the fin based on its prominent markings. This embedding can then be compared against previously stored embeddings for known individuals to present the most likely catalogue
matches quickly and accurately, as well as flagging to researchers previously unseen fins which may indicate new individuals in the survey area or a previously recorded individual whose prominent markings have been considerably altered since last sighting. This novel method for automatic photo-id minimises the need for manual analysis of the data, increases the accuracy of photo-id catalogues, allows for individuals not previously encountered to be flagged to the user, whilst speeding up the photo-id process. The underlying system framework is generalisable to any species with identifiable individualised prominent markings.

Population abundance and trends of the remaining viable population of dugongs (Dugong dugon) in the Western Indian Ocean: Implications for management and conservation
Evan Trotzuk, Bazaruto Archipelago National Park, African Parks, Kihei, HI

Although the dugongs of Mozambique’s Bazaruto Archipelago have been recognized as the last viable population along the East African coast, this population remains threatened by a variety of anthropogenic and natural pressures that must be addressed to ensure its persistence. This study aimed to establish recent trends in dugong population size through a series of aerial surveys of abundance carried out between 2017 and 2021. The evaluation also assessed hotspots of dugong distribution in the Bazaruto Archipelago where targeted conservation measures may prove most effective. Finally, the study modeled dugong population growth under varying scenarios to better understand the level of risk of anthropogenic mortality. A total of 325 SD 145 (CV = 0.39) dugongs was estimated from the 10 surveys. During the surveys, observers detected 345 dugongs, of which 42 (12%) were calves, in 163 different sightings. While the population estimates from this study and those from surveys in 2006 – 2007 (359 SD 137) suggest that the dugong population has not changed significantly over the past 15 years, the confidence intervals of these estimates are wide, such that they could conceivably be masking steady changes. The distribution of dugong sightings within the Bazaruto seascape over the 5-year period indicate two core zones, one of which occurs outside the limits of established conservation areas. Population Viability Analyses determined that a mortality of only 2 adult females per year could tip this dugong population into a decline. Together, these results provide strong motivations for the expansion of formal Marine Protected Areas in the region and suggest the importance of the relisting of the East African dugong population within the IUCN Red List of Threatened Species and CITES. Conservation efforts should focus on reducing mortalities of adult female dugongs, in particular, and protecting the hotspots of dugong activity from human-induced disturbances.

Ladoga ringed seal Pusa hispida ladogensis unique coloration pattern helps monitor population status
Irina Trukhanova¹, Vladimir Gromov², Olga Chirkova², Vlada Shahnazarova²
¹North Pacific Wildlife Consulting LLC, Seattle, WA, ²ICPO Biologists for Nature Conservation, Russia

Monitoring seal populations, studying individual behavior or social interactions is generally challenging due to seals’ cryptic life style and low efficacy of individual tagging when it comes to larger populations. Ladoga ringed seal Pusa hispida ladogensis is endemic to a fresh water Lake Ladoga and its population is considered Vulnerable yet it is largely understudied. Photoidentification is a novel method becoming increasingly popular in wildlife research and conservation due to intensive development of machine vision and automated recognition tools. However, even when such automated tools are
not readily available or under development which is the case for Ladoga ringed seal, photoidentification can be implemented using human observers for image processing. Ladoga seal imagery was collected in 2019 and 2020 at the major summer haulout sites on the islands located in the Northern part of the Lake Ladoga. In total, over 2500 seal portrait photos have been collected and processed. Medium to high quality images containing the left side of a seal with a clearly visible pattern were added to the catalogue, where each individual image was visually compared with the rest of the dataset in search for matching patterns. Over 500 seals were catalogued and the numbers of animals sighted more than once within one season or resighted between seasons are reported. We looked at individual haulout patterns, estimated observed and expected resighting probabilities, and made inferences about the total size of the seal grouping using the studied haulouts. Subsets of processed images were used as test datasets for automated recognition software, which, however, has been shown to have undesirably high misidentification rate at its present stage of development. The study is implemented with the support of South-East Finland – Russia CBC Programme 2014-2020 funded by the European Union, the Russian Federation and the Republic of Finland.

Diving into the past: recovering historic dive records to address modern questions
Emma Li Tsai¹, Dylan Schwilk¹, Michael Castellini², Jennifer Burns¹
¹Texas Tech University, Lubbock, Texas,
²University of Alaska Fairbanks, Fairbanks, Alaska

Time depth recorders (TDRs) have become an indispensable tool for studying the underwater behavior of marine mammals. Among the first TDRs was the Kooyman-Billups TDR (KBTDR) in the 1970s, which recorded the depth of a diving animal using a pressure-sensitive arm that moved an LED light across a roll of film. Although these devices have been superseded by sophisticated instruments that collect digital dive data, there is an abundance of data-rich analog records that are difficult to compare with newer data due to their non-digital format (i.e., film or paper records). Yet, historic analog records contain exceptionally valuable data about behaviors within ecosystems before significant anthropogenic impact or climatological shifts. Here, we describe novel computational methods for recovering historic (1970s – 1980s) Weddell seal (Leptonychotes weddellii) dive records gathered from KBTDRs. Our methodology includes digitization using a well-log scanner, image processing, and a suite of developed R functions that will be released as open-source code to the community. Collectively, these methods produce time-depth data similar to that gathered from modern instruments. Steps in the recovery process include using the geometry of the KBTDR to correct the arc in the records produced by the transducer arm, creating a reliable time scale from the time-keeping dots, and using original pressure calibration curves to calculate dive depths. The final output of the recovery process is a record with a full time and depth axis that can be read in as a TDR object into currently available dive analysis packages. This allows dive features such as ascent and descent rates, wiggles, post-dive surface intervals, and bout structure to be measured and compared to more recent studies in the same area. Given ongoing environmental challenges, recovery of historic datasets will be critical for understanding how dive behavior may have changed over long periods of time.

Environmental factors affecting prey item in the Rice’s whale (Balaenoptera ricei) habitat: an acoustic approach
Nicholas Tucker¹, Kevin Boswell², Jeremy Kiszka, Lance Garrison³
¹Florida International University, North Miami, FLORIDA, ²Florida International Universiy,
North Miami, FL, 1Miami, FL

There is little known about the Rice’s whale (*Balaenoptera ricei*). Their population is estimated to comprise as little as 33 individuals, and they inhabit relatively shallow waters in the Gulf of Mexico. Understanding the ecology of these animals is imperative to successfully conserve their numbers. A collaborative project amongst the National Oceanic and Atmospheric Administration’s Southeast Fisheries Science Center, Florida International University, and Scripps Institute of Oceanography was conducted to assess the ecology of this endangered whale. A bottom-up view may elucidate overall ecosystem health and help predict whale distributions throughout their habitat. This study used scientific echosounders to assess potential prey item distribution and intensity within the habitat. We collected data continuously during three research cruises over two years. Raw acoustic data were cleaned and classified using multiple frequencies. Three taxonomic groups were determined from target strength resonance models found in the literature and corroborated by the in situ data collected from trawls. We took the acoustically derived biomass among the different groups and directly compared them to environmental conditions using generalized additive models. Models were divided spatially and vertically to better understand the distribution of potential prey items. Other environmental factors that were considered were the effect of moon phase, sea surface temperature (SST), and sea surface salinity (SSS). Overall, we found strong relationships between the acoustically derived biomass and moon phase, SST and SSS. During the early summer, we found the largest distributions of prey biomass below 200 m, and during the late summer and early winter, we found large distributions of biomass ubiquitously in the water column. Overall, our models suggest a strong relationship between swim-bladdered fish aggregations and the distribution of Rice’s whales. This study indicates that environmental conditions may be used as predictors of prey availability and ultimately whale presence.

**Partitioning of diet resources within pinniped communities in coastal British Columbia; an application of novel high-throughput DNA techniques for diet estimation**

Strahan Tucker1, Sheena Majewski2, Chad Nordstrom1, Wendy Szaniszlo2, Angela Schulze2, Kristi Miller4

1Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, BC, 2Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, BC, 3Fisheries and Oceans Canada, Nanaimo, British Columbia, 4Fisheries and Oceans Canada, Nanaimo, BC

Once intensively hunted, pinniped populations are rebounding in size and distribution. Harbour seals (HS) and Steller Sea Lions (SSL) are year-round residents that breed in British Columbia (BC) and have recovered to historic levels. Over the last few decades, California Sea Lion (CSL) males began arriving (100’s) in BC from southern breeding grounds in fall, remaining till spring. More recently, large aggregations (1000’s) have been observed in BC, suggesting continued change in their migration or foraging patterns. In BC, these 3 species overlap in foraging range having access to similar prey fields. However, concurrent diet data for these species are sparse, taken opportunistically and irregularly. Therefore, little is known about how key prey are partitioned and competition manifested both within and between species over varying spatial and temporal scales. We sampled ~4000 scats between 2015-2019 at seasonal intervals collected at key haul-outs where species co-occurred or were found exclusively. Using a combination of hard-part analysis and novel high-throughput DNA techniques providing accurate species composition and size-class of prey, we found high inter- and intra-specific variability in diets with a mix of pelagic forage-and ground-fishes. Although proportions varied,
main prey constituents were similar amongst the 3 species with over half the diet consisting of herring and gadids. However, diets were consistently more diverse in SSL. Diets were highly variable between seasons and years and at both regional (West Coast Vancouver Island vs. Strait of Georgia) and sub-regional (haul out or estuary vs non-estuary) spatial scales. For HS, we have integrated DNA sex markers permitting differentiation between males and females. In all seasons and locations, diets varied significantly by sex. In changing coastal ecosystems there appears to be high potential for interference or exploitative competition particularly amongst otariids in this portion of their range, with the outcome on current populations unknown.

Assessing Fin Whale Habitat Use and Movements in the New York Bight to Inform Offshore Wind Development
Naomi A.M. Tuhuteru1, Joshua Jon van Berkel1, Sarah Courbis1, Kathleen Marean4, Kate McClellan-Press1, Lars O. Mortensen6, Henrik Skov6, Frank Thomsen7
1DHI A/S, Denmark, 2DHI Water & Environment, Inc., Lakewood, Colorado, 3Advisian Worley Group, Portland, Oregon, 4WSP, 5DHI, Hørsholm, Denmark, 6DHI A/S, Hoersholm, Denmark, 7DHI, Hørsholm, Denmark

There are ambitious goals of developing at least 9 MW of offshore wind power off the coast of New York by 2035. To inform planning, siting, and adaptive environmental management of offshore wind development, the New York State Energy Research and Development Authority has been supporting and considering a variety of wildlife surveys by federal, state, and academic organizations that provide data to better understand how protected species currently use the New York Bight and surrounding areas. Due to its abundance and regular occurrence, the fin whale is one of the key species when developing robust methods for assessing habitat use and distribution of key taxa in the New York Bight.

Fin whales have been generally predicted to occur near the continental slope but anecdotal reports and studies near the coast of Long Island extending down along the New Jersey coast suggest fin whales use these coastal areas year-round. Thus, fin whales appear to be less migratory than other baleen whales, which may reduce the value of seasonal mitigation during wind farm construction. However, detailed understanding of the fine scale distribution of fin whales on the shelf is unclear. Here, we use environmental data and observations to develop a dynamic habitat model for fin whales that predicts their seasonal habitat usage patterns in the New York Bight. We are applying that model as the key driver in an agent-based model (ABM) to demonstrate fin whale movement patterns. The ABM is using available data on fin whale movement parameters in the region. The habitat variables in our model are adjustable to make predictions based on anticipated environmental changes for long-term considerations or to predict near- and short-term movements to inform mitigation and monitoring. An expert committee is supporting this research, and we will have results to share in fall, 2021.

Reny Tyson Moore1, Kim Urian2, Jason Allen3, Carolyn Cush4, Jason Parham5, Drew Blount5, Jason Holmberg5, Jaime Thompson6, Randall Wells3
1Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, FL, 2Duke University Marine Lab, Beaufort, North Carolina, 3Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, Florida, 4Chicago Zoological Society's Sarasota Dolphin Research Program, San Diego, 5Wild Me, Portland, OR, 6Valdez AI Consulting

Photographic-identification (photo-ID) of
bottlenose dolphins is a well-established and useful tool for tracking individuals; however, it can be labor-intensive, especially when dealing with large catalogs and/or infrequently surveyed populations. Computer vision algorithms have been developed that can find a fin in an image, characterize the features of the fin, and compare the fin to a catalog of known individuals to generate a ranking of potential matches based on dorsal fin similarity. We examined if and how researchers use computer vision systems in their photo-ID process and evaluated the performance of the most commonly used systems to date using a long-term photo-ID database of known individuals curated by the Chicago Zoological Society’s Sarasota Dolphin Research Program. Survey results obtained for the “Rise of the machines – Application of automated systems for matching dolphin dorsal fins: current status and future directions” workshop held at the 2019 World Marine Mammal Conference indicated that most researchers still rely on manual methods for their Photo-ID process. Experimental evaluation of the finFindR R application, as well as the CurvRank, CurvRank v2, and finFindR implementations in Flukebook suggest that high match rates can be achieved with these systems, with the highest match rates found when only good to excellent quality images of fins with average to high distinctiveness are included in the matching process: for the finFindR R application and the CurvRank and CurvRank v2 algorithms within Flukebook more than 98.92% of correct matches were in the top 50-ranked positions, and more than 91.94% of correct matches were returned in the first ranked position. Our results offer the first comprehensive examination into the performance and accuracy of computer vision algorithms designed to assist with the photo-ID process of bottlenose dolphins and can be used to build trust by researchers hesitant to use these systems.

Southern right whale (Eubalaena australis) body condition and glucocorticoid levels at the South Africa breeding ground

Terriann Thavar¹, Fredrik Christiansen², Andre Ganswindt³, Mariano Sironi⁴, Marcela Uharte⁵, Lars Bejder⁶, Els Vermeulen⁷
¹University of Pretoria, Cape Town, South Africa, South Africa, ²Aarhus Institute of Advanced Studies, Aarhus, Denmark, ³Department of Zoology and Entomology, Mammal Research Institute, University of Pretoria, Pretoria, South Africa, ⁴Instituto de Conservación de Ballenas, Buenos Aires, Argentina, Buenos Aires, Argentina, ⁵University of California, Davis and Universidad del Centro de la Provincia de Buenos Aires, Argentina, Puerto Madryn, Chubut, Argentina, ⁶Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, Hawaii, HI, ⁷Mammal Research Institute Whale Unit, University of Pretoria, South Africa, Hermanus, Western Cape, South Africa

Southern right whales (Eubalaena australis) in South Africa have been extensively studied since 1979 through annual photo-identification surveys. The resulting database revealed an increased rate of reproductive failure in the last decade. As reproductive success is mediated through body condition, this study aimed to assess the body condition and physiological indicators of stress of southern right whales on the South Africa breeding ground at present, and compare it to historical data and other populations. For this, aerial photographs of southern right whales were collected using an unmanned aerial vehicle in September 2019 from which body condition was assessed. Additionally, blubber biopsy samples were collected for glucocorticoid (GC) analysis and compared to the body condition estimates of individual whales. To assess temporal change, analogue aerial photographs taken in coastal South Africa in 1988 and 1989 were selected and digitized for body condition measurements, and
compared to the 2019 data set. To determine population differences in body condition, the 2019 data set was compared to body condition data from breeding grounds in Argentina and Australia collected the same year. We found a positive relationship between body condition of lactating southern right whales of the South African population and their blubber GC levels, albeit in a small sample size. The temporal comparison revealed a 24% (SE=5.31) decrease in body condition between 2019 and 1988/1989. Furthermore, lactating females in South Africa were in significantly poorer condition compared to those in Australia and Argentina, at a magnitude of -8.1% (SE=3.07) and -7.1% (SE=3.31), respectively. The reduced maternal body condition in the South African population of southern right whales is of grave concern, as it is likely the main reason behind the reduced reproductive success that is decelerating population recovery.

Skin Transcriptome Analysis as a Potential Tool to Investigate Population Level Differences in Belugas

Ebru Unal¹, Vijender Singh², Robert Suydam³, Caroline Goertz⁴, Paul Wade⁵, Tracy Romano⁶
¹Mystic Aquarium, ²Computational Biology Core, University of Connecticut, Storrs, CT, ³North Slope Borough, Utqiagvik, AK, ⁴Alaska SeaLife Center, Seward, AK, ⁵National Marine Mammal Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, ⁶Mystic Aquarium, Mystic, CT

As long-lived top predators mostly inhabiting waters of the Arctic and subarctic, belugas are under continuous threat of anthropogenic stressors including climate change, pollution, noise, and habitat degradation, which in turn can negatively affect their health and viability. Of special concern is the isolated and non-migratory beluga stock of Cook Inlet, Alaska, which has been designated as endangered due to steep decline and lack of recovery. There is currently a need for health indicators or biomarkers that can be used to assess and monitor health and response to stressors in wild whales. In this study, skin samples collected from endangered (Cook Inlet) and stable (Bristol Bay, Eastern Chukchi Sea) belugas through remote biopsy darts, health assessment studies and subsistence hunts were utilized for RNA sequencing to investigate gene expression differences in their transcriptomes. Comparisons of 29 CI and 10 ECS belugas with 18 BB belugas displayed significant differences in gene activities as reflected in principle component and heatmap analyses. A total of 1,188 and 1,712 significantly regulated genes (p-adjusted<0.05, log2 fold-change>1) were identified in CI and ECS belugas in relation to BB belugas. The most differentially expressed genes were related with immune response and skin structural components showing downregulation in CI belugas when compared to BB belugas. Through Ingenuity Pathway Analysis (IPA), 152 and 49 significantly enriched (p-adjusted<0.05, z-score≥2) canonical pathways were identified in CI and ECS stocks in relation to BB stock, mostly including inhibited immune activity and cell signaling. Differences observed might be influenced by many factors including water temperature, pollutant load, timing of sampling, or different preservation methods, which are currently being investigated. Findings of this study suggests utilizing skin transcriptomes as a powerful technique to investigate inter- and intra-population differences at a large scale with potential to contribute to conservation and recovery of endangered whales.

Steller sea lion brand detection and identification on aerial images using deep learning approach

Ivan Usatov¹, Alexey Altukhov², Vladimir Burkanov³, Russel Andrews⁴, Thomas Gelatt³
¹Kamchatka Branch of the Pacific Geographical Institute FEB RAS, P-Kamchatsky, Kamchatka,
Unmanned aerial systems are now commonly used to survey marine mammals, providing overhead views and improving detection and identification of individuals compared with ground observers, and without the risk of manned aircraft. However, processing the large number of photographs is a complex, time-consuming task. In 2020, we flew 15 – 20 minute drone flights four times daily, from 12 June-10 August on the Tuleny Island SSL rookery (Russia), producing approximately 110,000 aerial images. We developed an algorithm for automated search and identification of branded Steller sea lions (bSSL) in aerial images based on U-Net and VGG-16 neural networks. We used a sequence of two U-Net models to search for bSSL in drone images and the VGG-16 model for automated identification of the unique alpha-numeric brand. The second U-Net model filtered out false positive errors (SSLs with scars similar to a brand pattern). To train the two U-Net models, 8,021 images were labeled by an expert. We replaced the last two layers of the VGG-16 model with new untrained layers, the last layer containing the number of neurons corresponding to the number of known classes of bSSL (400 classes, with an average of 65 images per class). U-Net detected bSSL in 26687 aerial images, producing 38098 image clips containing a bSSL and missing only a fraction of bSSL, mostly wet individuals in the surf zone. VGG-16 correctly identified 332 bSSL on 89.4% of those image clips. Each bSSL was recorded an average of 103 times per season. VGG-16 failed to identify the brand in 10.6 % of image clips (containing 11 bSSL). Therefore, of 110,000 images, a researcher would only need to manually review 4026 clips (< 4%). The use of drones and this algorithm should allow fast, safe and thorough detection and identification of bSSL, without disturbing the rookery.

Humpback Whale Song as a Cultural Pattern of the Pacific Ocean
Mirna Rebeca Valencia Vargas¹, Nicola Ransome², Marlenne Vazquez Cuevas³
¹Universidad Iberoamericana de México, Santa Ana, Santa Ana, El Salvador, ²Murdoch University, ³Proyecto Megaptera El Salvador, Acajutla, Sonsonate, El Salvador

All around the world during the winter, low latitude tropical breeding areas of humpback whales (Megaptera novaeangliae) become alive with the song of males. Like Nahuat, English and Spanish, the song of the humpback whale varies according to the geographical location of the different populations; that is to say, male humpback whales sing different songs depending on the ocean basin they inhabit and where they live. Each population of humpback whales has its own basic song structure which is made up of units, phrases and themes within a population all the male humpback whales will sing the same basic song; overtime the song evolves with additions of new units and phrases, however, individuals appear to learn the new additions and all males will be singing the same basic song. By studying the song of humpback whales we can learn about the distribution of the species, define populations, look at movements of individuals within populations and even estimate densities of males. The Central American population of humpback whales was classified as “Endangered” by NOAA in 2016, and in much of the region cetacean research has been limited; although humpback whales are known to occur in El Salvador, dedicated research has only just begun in the country and the song was yet to be described.

During the boreal winter of 2020 and 2021, we recorded the first song recordings of lone male humpback whales (n = 6) in Salvadorean waters.
Here we qualitatively and quantitatively present a detailed description of the structural characteristics of the song of the North Pacific humpback whale from the coast of El Salvador, we then compare song structure with other areas of the North Pacific and South Pacific. This study opens the door to continued research into humpback whale acoustics in El Salvador.

Setting the rhythm: how gene loss events shaped marine mammal circadian rhythmicity

Raul Valente¹, Luis Quádrio Alves¹, Matilde Nabais¹, Filipe Alves², Isabel Sousa-Pinto², Raquel Ruivo², Filipe Castro³
¹FCUP - Faculty of Sciences, University of Porto, CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, Porto, Portugal, ²MARE - Marine and Environmental Sciences Centre, Portugal, ³Interdisciplinary Centre of Marine and Environmental Research (CIIMAR), Matosinhos, Porto, Portugal

Understanding the molecular basis of phenotypic diversity is a central challenge of current evolutionary research. Particularly, gene loss mechanisms seem prevalent in lineages that endured drastic habitat transitions in the course of evolution, entailing niche-specific adaptations. By displaying an exclusive aquatic existence, marine mammals such as cetaceans and sirenians evolved unique patterns of locomotor activity, vigilant behaviour, thermoregulation and circadian rhythmicity. Remarkable examples were previously reported, with a strong genomic signature in some cetaceans and West Indian Manatee (Trichechus manatus latirostris) with respect to the molecular erosion of the genes encoding key-proteins in melatonin synthesis (Aanat, Asmt) and both melatonin receptors (Mtnr1a and Mtnr1b). With that in mind, here we investigate Cortistatin (Cort), a neuropeptide displaying an important role in mammalian biorhythm regulation, and expand our analysis of melatonin synthesis and signalling genes to the full range of sirenian species with available genomes, as well as previously unstudied cetacean species. Our findings indicate that Cort is non-functional in cetaceans, but remains functional in Sirenia. For melatonin-related genes, we found inactivating mutations in Dugong (Dugong dugon) and in the complementary set of cetacean species. Given the mutational landscape presented by both lineages, we suggest that these distinct inactivation events contributed to a profusion of phenotypic adjustments allowing the accommodation of adaptive solutions to specific ecological niches.

Multiple foraging strategies in apex marine predators

Ana Valenzuela Toro¹, Luis A. Hückstädt¹, Paul Koch³, Daniel Costa⁴
¹University of California Santa Cruz, ²Institute of Marine Sciences, University of California Santa Cruz, Santa Cruz, California, United Kingdom, ³University of California Santa Cruz, Santa Cruz, California, ⁴Department of Ecology and Evolutionary Biology, University of California Santa Cruz, Santa Cruz, CA

Otariids (fur seals and sea lions) are top predators that play critical roles in the structure and function of marine ecosystems through consumer-prey interactions. Studies addressing their foraging ecology have shown that sea lions prefer coastal environments compared to fur seals which mainly feed in offshore and pelagic waters. Furthermore, behavioral studies have shown that some sea lions species display distinct foraging patterns (epipelagic, mesopelagic, and benthic), with individuals specializing in one of these strategies. How prevalent this specialization is among species of sea lions and other otariids is unknown. Here, we examined the foraging and habitat preferences of three fur seals species (northern, Guadalupe, and South American) and four species of sea lions.
(Steller, California, Galapagos, and South American) by using carbon and nitrogen stable isotopes on bone collagen of adult individuals. We performed Hierarchical Cluster Analyses (HCA) using the Euclidean distance method to investigate the occurrence of intra- and interspecific foraging specializations. We found that all sea lions species display a distinctive three-clusters pattern, likely indicating the existence of three distinctive foraging strategies within each species. In contrast, fur seals species exhibit a less nested pattern with only two distinctive clusters within all species except for northern fur seals from the Bering Sea. This population displays a distinctive three-cluster pattern, similar to sea lions. We found no sex-related patterns in our clusters, suggesting that body size differences are not the main driver of these variations. The larger variability in sea lions’ foraging strategies compared to fur seals could result from physiological and energetic constraints associated with the dominant consumption of benthic prey within these species. Broadly, these results indicate the prevalence of high population-level foraging plasticity among benthic top predators, informing our predictions on how these animals will respond to environmental change, including shifts in prey availability.

Auditory masking of communication and echolocation bands of beluga whale (Delphinapterus leucas) by shipping noise in Cook Inlet, Alaska.
Jonathan Vallarta¹, Justin Eickmeier²
¹SLR Consulting (Canada) Ltd, Vancouver, BC, ²SLR Consulting, Guelph, Ontario

In recent decades, increased industrial development in Cook Inlet, AK, has raised concerns about the decline of the resident beluga whale (Delphinapterus leucas) population. Anthropogenic noise sources, such as commercial vessels, can cause auditory masking of communication and echolocation bands used by beluga whales in socializing, navigating, and foraging. This study is based on a sound transmission loss modeling from a source-level spectrum of a containership, positioned in Cook Inlet within the primary shipping channel (extending to 160 kHz to account for the high-frequency auditory range of beluga whales) and audiograms obtained from a live, stranded beluga calf in Cook Inlet (similar to audiograms of healthy, adult Belugas whales from a comparative Bristol Bay report). Whereas the communication band of belugas can be fully masked by ambient noise and underwater radiated noise from a containership positioned at 5,000 m, the echolocation band is only partially masked at shorter ranges (≤ 2,500 m). Auditory masking is assessed by critical ratios to express the ratio by which a pure tone signal must exceed the background noise levels to be audible. Upslope propagation of underwater noise is subject to increased multipath surface/bottom reflections and subsequent attenuation, contributing significantly to the attenuation of high frequencies and minimizing masking in the echolocation band of the beluga whale. Recommendations such as vessel speed reduction that have proven effective in regional testing for mitigating shipping noise are also discussed.

Community Science Program: A door to Cetacean Research and Community Engagement in the Colombian Pacific
Ann Carole Vallejo¹, Dalia Barragán-Barrera², Nohelia Farias-Curtidor²
¹R&E Ocean Community Conservation, Oakville, Colombia, ²Fundación Macuáticos Colombia, Medellín, Colombia

On the Pacific coast of Colombia, there are at least 23 cetacean species that are known to occur. The Gulf of Tribugá (GT) located in the Colombian Pacific, holds a high diversity of marine species and is an important reproductive area for humpback whales’ stock G (Megaptera
Even though there are numerous studies on humpback whales, there is still a vast gap on other marine mammals in the area. COVID-19 impacted cetacean research as well as the local community in 2020 due to the absence of scientists and lack of tourism. This study was an opportunity for both scientists and local fishermen, to come together and monitor cetacean occurrence, frequencies, and distribution through education and participation. Three local fishermen were trained on monitoring, data collection, species identification, and forms filling. A camera (Nikon Coolpix B600), GPS, reticular binocular, and species identification form were provided. A transect line (zigzag) was designed to cover the study area (GT) and was distributed in three consecutive days. The community science team carried out two monitoring surveys during the months of August and December. In a total effort of 36 hours, 24 sightings were recorded. Four species of cetaceans were sighted, and three species identified as humpback whale, Pantropical spotted dolphin (Stenella attenuata), and common bottlenose dolphin (Tursiops truncatus). Even though this study is in its early stages, and more practice and improvements are needed, the opportunity for cetacean research and community engagement have great value. The GT might also be an important area for small cetaceans as it is for humpback whales, and thus the continuation of this program could provide more information on small cetaceans, determining their distribution and habitat use, evaluating potential threats, and working for their conservation by taking management measures.

The ups and downs of humpback whale motherhood: quantifying the cost of maternal investment and calf growth on their Hawaiian breeding grounds and Southeast Alaskan foraging grounds

Martin van Aswegen¹, Andrew Szabo², Jens Currie³, Stephanie Stack³, Adam Pack⁴, Ted Cheeseman⁵, Shannon Atkinson DeMaster⁶, Lars Bejder⁷

¹Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Honolulu, Hawaii; ²Alaska Whale Foundation, Petersburg, Alaska; ³Pacific Whale Foundation, ‘University of Hawaii at Hilo, Hilo, Hawaii; ⁴Southern Cross University, ⁵University of Alaska Fairbanks, ⁶Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, Hawaii, HI

North Pacific humpback whales (Megaptera novaeangliae; HBW) undergo one of the longest migrations of any mammal, travelling from high-latitude foraging grounds to sub-tropical breeding grounds. Given the additional energetic costs associated with reproduction in capital breeders, understanding how maternal and calf body condition (BC) varies post-partum is important for effective management. Between January 2019 and November 2020, we conducted 646 unoccupied aerial system (UAS; drone) flights to measure HBW BC in Hawaii (HI) and Southeast Alaska (SEAK). The body condition index (BCI) of 270 HBW mother-calf pairs was quantified to determine the relationship between maternal BCI and calf BCI in addition to the cost of reproduction across breeding and foraging grounds. Maternal BCI was a significant predictor of calf BCI in both HI (p<0.001, R²=0.25, n=184) and AK (p<0.001, R²=0.10, n=86). After giving birth in HI and returning to SEAK, mean maternal BCI declined by 22.1% while mean calf BCI and total length (TL) increased by 21.7% and 60.8%, respectively. Mean BCI of 310 unknown-sex adults, however, increased by an average of 17.3% during the same time period. Three mother-calf pairs were measured in both HI and SEAK, providing direct comparisons of individual BCI over an average of 191 days (range=139-223). Mean maternal BCI declined by an average of 16%, while mean calf BCI and TL increased markedly (BCI=24.4%; TL=80.5%). Notably, one of the three calves increased in TL and body volume by
112% (3.57m to 7.60m) and 974.3% (0.78m$^3$ to 8.38m$^3$) in 223 days, respectively. These preliminary results demonstrate the high energetic costs associated with reproduction with particular pressures facing mothers who remain in below-average BC despite returning to foraging grounds. Quantifying such costs over large spatial and temporal scales will provide important insights into how HBW health may vary naturally and in response to environmental and anthropogenic stressors.

Beyond the barcode: what can fecal DNA tell us about prey stocks, abundance, and more? A test case in Southern Resident killer whales

Amy Van Cise$^1$, Bradley Hanson$^2$, Candice Emmons$^3$, Kim Parsons (she/her)$^4$

$^1$NOAA Northwest Fisheries Science Center, Seattle, WA, $^2$Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, $^3$NOAA Northwest Fisheries Science Center, Seattle, Washington, $^4$Northwest Fisheries Science Center, NOAA Fisheries, Seattle, WA, SEATTLE, wa

Recent advances in DNA metabarcoding have allowed conservation geneticists to characterize the diets of marine top predators using fecal samples, which is advantageous over previous methods in being both a non-invasive sampling method and representative of an individual’s recent diet. While prey metabarcoding data complements traditional analyses of prey remains and stomach contents, and has vastly improved ongoing cetacean diet studies, many questions remain unanswered that are ultimately important to understanding the dietary and energetic needs of these predators. For example, sampling prey remains or DNA metabarcoding of fecal matter generates relative estimates of abundance for prey species consumed, but fall short in terms of estimating the number of prey items consumed or identifying genetic stocks from prey sequence data. Here we move beyond mitochondrial DNA based prey metabarcoding to explore the use of nuclear sequencing to answer these types of questions. We illustrate a multi-step bioinformatic pipeline to address the challenges associated with sequencing DNA in a mixture. In three major steps, the pipeline is designed to: 1) determine species composition of a sample using traditional metabarcoding, 2) estimate the number of individuals in a sample by adapting likelihood-based methods developed for forensic analysis of blood samples, and 3) determine proportional contribution of source stocks to the sample by adapting traditional mixture models to incorporate an unknown number of individuals and stocks. We describe the power of this pipeline to generate data beyond prey species identification based on an analysis of 93 in situ simulated mixtures of DNA from salmonids and 94 fecal samples collected from free-ranging Southern Resident killer whales.

Ice queen no more: A leopard seal (Hydrurga leptonyx) makes history living in warmer temperatures with multi-year residency in New Zealand urban areas

Krista van der Linde$^1$, Ingrid Visser$^2$, Rick Bout$^3$, Tracy Cooper$^1$

$^1$WWF-NZ, Wellington, New Zealand, $^2$Orca Research Trust, Tutukaka, New Zealand, New Zealand, $^3$Wellington, New Zealand

Leopard seals (Hydrurga leptonyx de Blainville 1820) are widely distributed throughout the waters of Antarctica, with a preponderance to inhabit pack ice where the average sea temperatures are typically −2°C and the average air temperatures are typically −10°C. However, leopard seals have been also been recorded regularly in the circumpolar Subantarctic Islands and as vagrants further north. Recently, leopard seals have been classified by the New Zealand Government as a Resident species due to their year-round and widespread presence in New Zealand. Here, we present a case study of one leopard seal (catalogued as number HLNZ001)
providing the first evidence of long-term individual residency in New Zealand waters. The individual (identifiable by her unique pelage patterns and scars) is an adult female and she has been documented >1,500 times between 2012 and 2021. She has exhibited year-round residency, frequently inside harbours and estuaries, for more than nine years, which is arguably the longest documented residency of any free-ranging leopard seal worldwide.

HLNZ001 was documented in four New Zealand regions (Northland, Auckland, the Bay of Plenty and Otago), spending the past six years in the former two, moving between them predominantly during the Austral autumns and winters. The water temperatures in these regions were typically between 13.8 and 23.2°C whilst the air temperatures rarely fell below 8°C in winter but reached over 28°C during summer. She measured ~3m in length and her body condition was classified as poor, good and excellent, with no identifiable correlation between body condition, regions or seasons. The majority of records show HLNZ001 hauled out on man-made floating pontoons in urban environments, with occasional records on beaches, in mangroves or in the water. We discuss possible reasons for the residency of HLNZ001 in New Zealand waters, including suitable habitats and locally abundant food resources.

Applying Artificial Neural Networks for the detection of baleen whales in the Chiloense ecoregion (Chile)

Mike van der Schaar¹, Florence Erbs², Loanne Pichot³, Serge Zaugg⁴, Sonia Espanol⁵, Michel André⁶

¹UPC, Vilanova i la Geltrú, Spain, ²Laboratory of Applied Bioacoustics, Technical University of Catalonia, Vilanova i la Geltrú, Barcelona, Spain, ³Equipe Neuro-Ethologie Sensorielle (ENES), Université Jean Monnet, Saint-Étienne, France, ⁴Laboratory of Applied Bioacoustics, Vilanova i la Geltrú, ⁵MERI Foundation, Santiago, Chile, ⁶Technical University of Catalonia, Vilanova i la Geltrú, Barcelona, Spain

The Chiloense marine ecoregion is recognized as a region of highest value for cetacean species such as blue (Balaenoptera musculus) and sei whales (Balaenoptera borealis), that were both subject to intense commercial whaling in this region. Nevertheless, there is a lack of data concerning the spatio-temporal distribution of these populations. To address this knowledge gap there is a need to develop monitoring techniques that can accurately detect whale presence over large distances and across seasons. Here, we applied advanced Deep Neural Networks techniques to automatically detect sei and blue whale acoustic presence in the Gulf of Corcovado (Chile). Based on published descriptions of the sei and blue whale acoustic repertoire, vocalizations were identified in recordings from an autonomous platform deployed in 2012-2013 at the entrance to the Gulf of Corcovado, Chile. Sei whale downsweep and blue whale southeast Pacific songs were manually labelled to train a whale classifier using Convolutional Neural Networks (CNN). The sei and blue whale classifier performance had an average precision of respectively 0.94 and 0.92. This model was run over the full dataset (June 2012 to April 2013) with an optimized threshold. For the sei whale, it resulted in a recall (probability of detection) of 96%, and a precision of 86%. For the blue whale we obtained a recall of 96% and a precision of 99%. Our results showed that sei whales were mainly present from the end of October 2012 to mid-April 2013 (peak presence during January 2013), while blue whales were acoustically present in June 2012, absent during the austral winter and present again from January to April (peak presence during April). The CNN model developed here is suitable to be executed on low power boards such as RPIs, allowing its application in real-time warning systems aimed at preventing collisions between ships and whales.
**Sex difference in non-signature whistle production in bottlenose dolphins**

Campbell Van Horn¹, Frants Havmand Jensen², Vincent Janik³, Evan Morrison⁴, Randall Wells⁵, Laela Sayigh⁶

¹Hampshire College, Brooklyn, NY, ²Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, ³University of St Andrews, St Andrews, Fife, United Kingdom, ⁴Woods Hole Oceanographic Institution, ⁵Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, Florida, ⁶Woods Hole Oceanographic Institution/Hampshire College, Woods Hole, Massachusetts

Individually distinctive signature whistles (SW) of bottlenose dolphins have been the focus of intensive study for decades. However, signature whistles are known to comprise only about 50% of whistles produced by free-swimming dolphins. The rest are lumped together as “non-signature whistles,” (NSW) and almost nothing is known about how these whistles function. The goal of this study was to examine whether there is a difference in the production of NSW vs SW in the vocal repertoires of females and males, and specifically determine if non-signature whistles are produced equally by males and females. We examined 51,351 whistles from 201 recording sessions of members of the resident Sarasota, Florida USA dolphin community (60 males, 74 females) ranging in age from 2 to 47 years, of which 46 were dependent calves (21 male, 25 female). Dolphins were recorded during brief catch and release events for the purpose of health assessments from 2005-2019. Measuring ratios of NSW to Total whistles (TW), adult (independent) males produced significantly higher proportions of NSW out of TW than did females (p=0.0025). Of 11,413 whistles produced by adult males, 3,759 (32.9%) were non-signatures, while of 15,836 whistles produced by females, 2,785 (17.6%) were non-signatures. The present study is the first to quantify and confirm this sex difference in NSW production for the common bottlenose dolphin. These findings provide insight into possible roles of non-signature whistles in the dolphin communication system, and open the door to playback experiments and acoustic tag studies to investigate their functions.

**Desktop review of southern right whale (Eubalaena australis) offshore sightings south of 40th degree S (1980-2020)**

Cuyler van Jaarsveld¹, Emma Carroll², Dr. Claire Charlton³, Andre Ganswindt⁴, Els Vermeulen⁵

¹University of Pretoria, Pretoria, Gauteng, South Africa, ²University of Auckland, Auckland, New Zealand, ³Curtin University Centre for Marine Science and Technology, Western Australia, Australia, ⁴Department of Zoology and Entomology, Mammal Research Institute, University of Pretoria, Pretoria, South Africa, ⁵Mammal Research Institute Whale Unit, University of Pretoria, South Africa, Hermanus, Western Cape, South Africa

Southern right whale (Eubalaena australis; SRWs) distribution and presence outside of their wintering breeding grounds remain poorly understood. An improved understanding of SRW offshore sightings south of 40°S is required to...
provide insight on contemporary feeding grounds and foraging ecology. The International Whaling Commission Southern Ocean Research Partnership (IWC-SORP) Theme 6 the Right sentinel to climate change, aims to assess the linkages between foraging ecology, demographics, health, and climate. This desktop study will collate all published information, grey literature and other readily available information on the location and relevant environmental characteristics (lat/long, bathymetry, distance from shore, etc) of global SRW sightings south of 40°S into a comprehensive review over the period 1980-2020 (post-Soviet whaling), in which new data can be easily integrated. The aim is that such a comprehensive review will ultimately aid in the future identification of contemporary feeding grounds as well as in the selection of environmental variables relevant to these feeding grounds, to assess the relationship of oceanographic conditions, prey availability and SRW reproductive success (mediated through foraging success).

Analysis of Drone-captured Breathing Synchrony Reveals Social Structure and Leadership Behavior in Male Risso’s Dolphins

Ida van Ommeren¹, Karin Hartman², Pieter Andries van der Harst³, Raul Vilela⁴

¹University Utrecht, ²Nova Atlantis Foundation, Bakkum, Azores, Netherlands, ³Nova Atlantis Foundation, Bakkum, Netherlands, ⁴Bioconsult-SH, Husum, Germany

Group living has benefits but also costs. The advantages are related to the degree of group cohesion; if social unity is weak, the group risks losing them. The benefits and costs of group living may differ between individuals and are influenced by factors such as dominance relations, leadership behaviors, social preferences, associations and spatial position within the group. Therefore, studying these indicators may reveal crucial information concerning the social organization of a group. Risso’s dolphins (Grampus griseus) have a unique social structure in which adult males can form long-term stable groups. This species is known to exhibit synchronized breathing, which is suggested to be an important indicator of coordinated behavior, expressing social preferences and promoting cohesion. This study examines association patterns of 36 male Risso’s dolphins, belonging to four social units, during five seasons (2016-2020).

We analyzed 79 drone videos (>15 hours) in which we captured 16,788 breathing events along with individual spatial positions relative to the group. In total 2,155 synchronized breathing events and 548 leadership behaviors were recorded. Next, we applied a social network analysis and Dynamic Time Warping to interpret and visualize the data. The results show differences between groups in synchronized breathing rates, applying both to group members and additional (outsider) individuals (often of unknown sex, but in some cases confirmed females). Differences in synchrony rates between groups appear to be related to group size and -stability and age class. The observed breathing synchrony with both group members and outsiders may reveal a drive to maintain bonds within and outside the group, which is particularly interesting when it concerns females. In the largest stable group (n=13), correlations were found between spatial positioning, breathing synchrony, and leadership behaviors, potentially indicating a dominance hierarchy and leadership patterns. Further research is needed to deepen the understanding of these findings.

Assessing Androgen Cycles in Male Southern Right Whales (Eubalaena australis) Through Baleen Analysis

Meghan van Zyl¹, Els Vermeulen², Kathleen Hunt³, Alejandro Fernandez Ajo⁴, Andre Ganswindt⁵

¹University of Pretoria, Kempton Park, South Africa, ²Mammal Research Institute Whale Unit, ³WildLife and Nature Trust, Gansbaai, South Africa, ⁴National Marine Mammal Laboratory, National Oceanic and Atmospheric Administration, Boulder, Colorado, USA, ⁵Ganswindt, Ganswindt
University of Pretoria, South Africa, Hermanus, Western Cape, South Africa, 1Smithsonian-Mason School of Conservation, Manassas, Virginia, 2Oregon State University, Marine Mammal Institute, GEMM Lab, Instituto de Conservacion de Ballenas de Argentina, Oregon State University, Flagstaff, AZ, 3Department of Zoology and Entomology, Mammal Research Institute, University of Pretoria, Pretoria, South Africa

Long-term monitoring has revealed a notable increase in calving intervals of female southern right whales (Eubalaena australis; SRWs) on their winter breeding ground in coastal South Africa. As reproductive success is mediated through body condition and foraging success, potential links between environmental variability, prey availability, and reproductive success are being investigated. Preliminary results indicate a decline in body condition of adult female SRWs over the past two decades and a shift in foraging strategy and location, with possible consequences on female reproductive cycles. However, stress and malnutrition may also affect male reproductive success through decreased quantity and quality of sperm and/or reduced testosterone, especially in sperm competitors such as SRWs. Male mysticete reproductive cycles can be assessed via analysis of baleen, which in adult males contains regularly spaced areas of high testosterone content (i.e., annual testosterone cycles). There are indications that males may "skip" testosterone cycles after periods of stress in some species. However, the occurrence of testosterone cycles in males, and possible effects of stress, have not been assessed in SRW.

In light of the above, we studied testosterone patterns across the full length of baleen plates from three adult male SRWs stranded on the South African shore between 1994 and 2020. Baleen plates were sampled at 2cm intervals, each interval representing approximately 30 days, with immunoreactive testosterone assessed using enzyme immunoassays. Descriptive statistics were used to evaluate the pattern of testosterone concentrations, and stable isotope profiles were used to assess annual and seasonal testosterone cyclicity using autocorrelation analysis. Temporal changes in periods of elevated testosterone concentrations were assessed. Our main working hypothesis is that the decreased foraging success in the South African population of SRWs affected testosterone production in adult male SRWs, possibly affecting their breeding success.

Squid Games: Risso’s Dolphin Occurrence in the Southern California Bight and Interaction with the Squid Fishery around Catalina Island
Alexandra Vanderzee1, Brandon Southall2, John Calambokidis3
1Cascadia Research Collective, 2Southall Environmental Associates, Inc., Aptos, California, 3Cascadia Research Collective, Olympia

Risso’s dolphins are a gregarious odontocete known to have a wide distribution in the Southern California Bight. Using photo identification techniques, we report on efforts to document distribution, movement, and interactions of Risso’s dolphins with squid (generally thought to be their primary prey). While our surveys were conducted more widely in the Southern California Bight from 2010 to 2012, in subsequent years (2013-14 and 2019-21) our observations focused more on the Catalina Island area. From 2010-2014, Risso’s dolphins were encountered 506 times in which 1,041 unique individuals identified with the highest number of Risso’s observed in 2013 and 2014 (193 and 82 sightings respectively) with most of these sighted around Catalina Island. As part of a 2nd study targeting other species, our observations from 2019 to 2021 were conducted solely around Catalina Island and confirmed frequent sightings in this area. During most of our observations, Risso’s were primarily seen in slope waters (also documented with deployments
of tags), however, in two periods (Fall of 2013 and 2021) Risso’s were concentrated close to shore and into some of the harbors and inlets on the NE side of Catalina Island. This coincided with high densities of spawning market squid and in December 2021 (later in the season than our previous work) we observed Risso’s associated in close proximity with commercial boats fishing at night for squid near shore, and direct interactions were observed with the Risso’s dolphins that would be aggregated around some of the boats. Discussions with squid fishermen indicated that the association between squid fishing operations and Risso’s (sometimes referred to as “squid pigs”) was not new. Catalina Island is clearly an important area for Risso’s dolphins though the number and habitats they use seem to vary by year and season, apparently tied to squid distribution.

Analysis of South American Sea Lion Dentition: A Preliminary Study of Peruvian Pinniped Tooth Structural Composition
Tate Vangellow¹, Amy C. Hirons², Michael Adkesson³, Susana Cárdenas-Alayza⁴
¹Nova Southeastern University Halmos College of Arts and Sciences, ²Nova Southeastern University, Dania Beach, FL, ³Chicago Zoological Society, Brookfield, IL, ⁴Universidad Peruana Cayetano Heredia, Lima, Lima, Peru

Teeth from marine mammals have been utilized to determine age through its growth layer groups (GLGs). South American sea lions, Otaria byronia, between the ages of 2-8 years are juveniles, and they begin mating as reproductive adults at 9 years of age or greater; sea lions can live up to approximately 20 years. The distinctive neonatal line separates the dentin of the pulp cavity from the external cementum of the tooth root. Alternating light/dark layers in the dentin combined represent 1 year. Ten canine teeth from 8 male and 2 female sea lions from Punta San Juan, Peru were separated by age as 2 adult males (10+ years), 2, 5-year-old (one each sex), 4, 6-year-old (all males), and 2, 7-year-old (one each sex) juveniles. Post-aging cross-reference with field data sheets tended to confirm these ages. Length and diameter of each canine was conducive with the age of each animal, but no correlation was found within the small sample size. The volume of filled pulp cavity (dentin) was not always relative to the age of each animal. Thickness of GLGs is known to vary with diet and a decrease in the mineral density can be associated with the intensity of El Niño–Southern Oscillation (ENSO) events. As these sea lions reside within the Niño 1+2 zone, their diet varies annually relative to the ENSO state, likely affecting the width of the annual GLG. Future research will focus on increasing tooth sample size and assessing GLG stable carbon and oxygen isotope ratios for trophic and water mass confirmation and inorganic contaminant concentrations.

Population estimates of resident Sperm whales (Physeter macrocephalus) in Mauritius and their integration in Marine Spatial Planning
Svetlana Barteneva¹, Hugues Vitry¹, Michel Vély², Jean-Luc Jung³, Justine Girardet¹
¹Marine Megafauna Conservation Organisation (MMCO), Mauritius, ²Megaptera, Paris, France, ³BioGeMME UBO, Brest, France, ⁴Museum d’histoire naturelle, Brest, France

The problem of the lack of scientific data on cetaceans in the Indian Ocean remains relevant. Today Sperm whales (Physeter macrocephalus) are globally designated as Vulnerable on the IUCN Red List of Threatened Species and exposed to a variety of anthropogenic threats. Small populations are particularly vulnerable. Sperm whales in Indian Ocean along the west coast of Mauritius have been studied between 2013 and 2021 using photo-identification, capture-recapture methods, genetic analyzes and movement tracking using satellite telemetry. One of our goal was to provide an assessment of the population of resident Sperm whales in
Mauritian waters, its dynamics and vulnerability. The analysis showed that around 30 individuals appear to be resident. During the study period, 12 births were registered (7 males and 5 females), 4 individuals disappeared and 1 found dead. These observations are correlated with an average annual population growth of about 4%/yr, a disappearance of about 0.018/yr and a birth rate of about 0.082/mature female/yr (a mean inter-birth interval of about 10-12 years). These indicators are better than the global average, but in the same time, a disproportionate sex ratio of immatures in favor of males takes place and an unstable females' age distribution, which makes this population extremely vulnerable and indiscriminate anthropogenic activities can negatively affect local population prospects, up to extinction.

Therefore, for conservation and effective management such small populations of vulnerable species require close attention and mandatory mitigation measures. This study not only expanded data on Sperm whales in the Indian Ocean, but also allowed to attract the attention of the authorities of Mauritius to protect local Sperm whales and develop recommendations to integrate large whales into the Marine Spatial Planning. And an interesting question is whether the environment is a factor in the disproportionate secondary sex ratio in the Sperm whale population of Mauritius?

**Cortisol, lactate, and ammonia plasma concentrations associated with performance-based physical activities in bottlenose dolphins (Tursiops truncatus)**

**Maria Vences**, Don Bergfelt, Danielle Merritt, Rocio Canales, Luis Pablo Hervé-Claude, Roberto Sanchez Okrucky, Loveness Dzikiti

1Dolphin Discovery, Mexico, 2Ross University School of Veterinary Medicine, 3Grupo Dolphin Discovery, Cancun, Quintana Roo, Mexico

Evaluation of metabolic characteristics encompassing short-term performance-based physical activities has fundamental and practical implications to enhance management practices associated with dolphin-human swim interactions in aquatic facilities and the wild. A total of 10 male and female bottlenose dolphins (*Tursiops truncatus*) were involved in a crossover design where animals first participated in a dolphin-human swim interaction group and, after a washout period, a no swim interaction group (control). For the interaction group, the morning session involved various degrees of physical activity with and without a human participant and occurred between 0842 to 1005 h and an afternoon session which occurred between 1354 to 1454 h. For the control group, dolphins swam freely in separate pens with light training in the morning and afternoon during corresponding times. Blood samples were collected within 30 min before and 30 min after each morning and afternoon session in the swim interaction group and at corresponding times in the control group. Plasma concentrations of cortisol, lactate, and ammonia were determined using conventional enzyme immunoassay and clinical chemistry techniques. While there were minimal to nil significant effects of group on cortisol, lactate, and ammonia concentrations, there were main effects of time (before vs after an interaction or no interaction). With groups combined, mean cortisol was 56% higher (P<0.021) before vs after in the morning and, similarly, 42% higher (P<0.004) before vs after in the afternoon sessions. A group x time interaction (P<0.005) for ammonia during the afternoon session indicated a decline in concentrations in the swim interaction group but not the no interaction group. Regardless of groups and time, cortisol was 59% higher (P<0.001) during the morning vs afternoon sessions and, conversely, lactate was 68% lower (P<0.001) in the morning vs afternoon sessions. These results continue to support the concept that short-term performance-based physical activities are not necessarily metabolically challenging in bottlenose dolphins conditioned for dolphin-human swim interactions.
Long term population assessment of gray (Halichoerus grypus atlantica) and harbor (Phoca vitulina) seals at the Isles of Shoals, ME USA.

Jessica Veo1, Andrea Bogomolni2, Nadine Lysiak3, Lisa Sette4
1None, Boxford, MA, 2Woods Hole Oceanographic Institution, 3Suffolk University, Stockton Springs, ME, 4Center for Coastal Studies, Provincetown, Massachusetts

Every summer since 2011, the seal research program at the Shoals Marine Laboratory has surveyed a gray and harbor seal haul out on Duck Island, a small rocky island off the coast of southern Maine. Each season, between twenty and thirty-eight boat-based photographic surveys were conducted. Photographs were used to produce minimum abundance estimates for gray and harbor seals. Notable pathologies, entanglements, and injuries were recorded. Additionally, photographic mark recapture was utilized to identify individuals based on unique pelage, scars, tags, or brands. From 2011-2015, the average minimum abundance estimates of both harbor and gray seals increased each year. However, harbor seal numbers began to decline in 2016. In 2018, for the first time in the study, the average minimum abundance estimate of gray seals outnumbered that of harbor seals. The decrease in harbor seals from 2015 to 2019 was found to be significant (p=.0029). Since 2011, 201 entangled seals have been recorded, 74 of which were entangled with visible monofilament netting. Though entangled seals of both species were seen every year, there were no significant differences in mean entanglement prevalence between any year and between any species. Using photographic mark recapture, 144 unique seals have been identified at least twice on Duck Island. This long term standardized assessment of the seals at Duck Island is providing insights into the health and population trends of Gulf of Maine, the fastest warming body of water on the planet.

Sharing is caring: Social perception of the interactions between human activities and the Juan Fernandez fur seal (Arctocephalus philippii)

Valentina Vergara-Caro1, Renato Borras-Chavez2, Victor Castillo3, Luciano Hiriart4, MICHAEL E GOEBEL5, Carla Rivera6, Rodrigo A Estévez7
1NGO Costa Humboldt, Puerto Montt, Chile, 2Center of Applied Ecology and Sustainability-CAPES, Pontificia Universidad Católica de Chile, Punta Arenas, Chile, 3NGO Costa Humboldt, Valdivia, Chile, 4NGO Costa Humboldt, Chile, 5University of California Santa Cruz, La Jolla, CA, 6Center of Applied Ecology and Sustainability-CAPES, Pontificia Universidad Católica de Chile, Santiago, Chile, 7Centro de Investigación e Innovación en Cambio Climático (CIIC) - Universidad Santo Tomás, Chile

The Juan Fernandez fur seal (JFFS) was heavily hunted during the XVIII and XIX centuries driving the population almost to extinction. From the first 200 individuals observed in 1965, a steady and arguably exponential growth of the population has been suggested. Our team is currently estimating total abundance for the archipelago after 15 years since the last complete estimation. However, recent theoretical estimations suggest that numbers could be ~200,000. The archipelago’s most important economic activities are associated with artisanal fisheries and the increasing numbers of JFFS are resulting in human-fur seal interactions never registered before. We present preliminary socioecological data on the assessment of these interactions for the two islands with active fishing communities: Robinson Crusoe and Selkirk. 90 Surveys (54 questions each) and 22 interviews were conducted to fishermen. Of this number, ~76% perceived that the JFFS do not
interfere in fishing activity (i.e. when placing bait in lobster pots or fishing hooks or when capturing bait or target species). In addition, no accidents were registered with onboard motors or with daily routine activities associated with fishing. This was consistent with our findings while conducting the JFFS census, where no entangled or animals caught by anthropogenic artifacts were observed. No adverse interactions with artisanal fisheries have been recorded. However, ~98% of surveyed people agree that JFFS have increased and are occurring in areas previously unoccupied. Most importantly, if the complete human-population is considered (total sample size: 282 surveys), 51% perceive that increasing numbers of JFFS, would alter the future everyday activities of the local people. Differences between islands are discussed. The present work represents the first attempt at recording human-JFFS interactions and is the first step toward long-term monitoring of future interactions of a relationship that has exist for centuries.

The Southern Right Whale Consortium
Els Vermeulen¹, Dr. Claire Charlton², Stephen Burnell³, Kris Carlyon³, Barbara Galletti Vernazzani⁴, Karina Groch⁵, Will Rayment⁶, Vicky Rowntree⁷, Mariano Sironi⁸, Joshua Smith⁹, Mandy Watson¹⁰, Marcela Uhart¹¹.¹ Mammal Research Institute Whale Unit, University of Pretoria, South Africa, Hermanus, Western Cape, South Africa, ²Curtin University Centre for Marine Science and Technology, Western Australia, Australia, ³Eubalaena Pty. Ltd., Adelaide, South Australia, Australia, ⁴Centro de Conservación Cetacea, Santiago, Chile, ⁵Instituto Australis - Right Whale Project, Imbituba, Brazil, ⁶University of Otago, Dunedin, ⁷Department of Biology, University of Utah, Salt Lake City, Utah, ⁸Instituto de Conservación de Ballenas, Buenos Aires, Argentina, Buenos Aires, Argentina, ⁹Murdoch University, Perth, Australia, ¹⁰Department Climate Change, Energy, Environment and Water, ¹¹University of California, Davis and Universidad del Centro de la Provincia de Buenos Aires, Argentina, Puerto Madryn, Chubut, Argentina

Theme 6 of the International Whaling Commission – Southern Ocean Research Partnership (IWC-SORP), “The right sentinel for climate change: linking foraging ground variability to population recovery in the southern right whale (SRW)”, aims to provide an over-arching research programme linking SRW population dynamics and health with foraging ecology, and assessing these linkages on a global scale. Its ultimate goal is to investigate the impact of past and future climate variation on SRW recovery. Being a multi-national collaborative research programme, there is a growing need for a formal agreement outlining the intent to collaborate on global comparative studies to progress priority research questions for the conservation and management of SRWs. This resulted in the formation of the “Southern Right Whale Consortium” (SRWC). The SRWC aims to formalise and facilitate the multi-national collaborations forthcoming of the IWC-SORP Theme, as to allow the generation of scientific information on, and management strategies for, SRWs on a circumpolar scale, which would not be achievable by individual research groups. Ultimately, this Consortium aims to improve the conservation status of SRWs on a global scale. The SRWC is formed by means of a Memorandum of Understanding (MoU), and annexed projects. The MoU specifies the ways in which Partners will work collaboratively with each other, and share data, towards the achievement of the aims and objectives of the Consortium. It is purposely very broad to allow for growing collaborations; new projects and (inter-)region specific data sharing agreements will be detailed under separate annexes where necessary.

Going forward, additional partners to the Consortium, and SRW related research projects, are strongly encouraged! Ultimately, it is aimed that the SRWC provides a platform for
international researchers and partners to share data through the development of standardized circumpolar SRW databases in order to address key scientific questions for species assessments, conservation and management.

**Cetacean Response To Dolphin Watching Vessels In The Eastern Algarve (Faro, Portugal): Preliminary Results**

Alfredo Miguel Viana Rodrigues¹, Gonçalo Fonseca², Pedro Santos³

¹Ocean Vibes Algarve, Olhão, Algarve, Portugal, ²Faculdade de Ciências e Tecnologias - Universidade do Algarve, Faro, Algarve, Portugal, ³Ocean Vibes Algarve, Olhão, Algarve, Portugal

Cetacean based tourism such as dolphin & whale watching is a worldwide growing industry including in Portugal. The Algarve is one of the main dolphin watching hotspots of the country, with 55 companies licensed in the area and 141 boats operating. Most of the current boat pressure relies on the western Algarve, however, tourism at the eastern area is developing at a fast rate, and the number of licensed vessels is increasing throughout the years in Faro area. Dolphin watching activities can induce behavioral changes that may negatively affect cetacean populations, thus there is a concern that these activities could be detrimental to target species. Behavioral changes caused by anthropogenic disturbance might have a great impact on key activities for cetaceans. No previous studies were conducted in Faro (Portugal) to assess the effects of dolphin watching vessels density on local target species such as the Common dolphin (*Delphinus delphis*) and the Bottlenose dolphin (*Tursiops truncatus*). Moreover, the local dolphin watching carrying capacity is not known, thus increasing a risk of developing a long-term unsustainable activity. The aim of this study is to assess cetacean's reaction upon different dolphin watching boat density. From 2019 until early 2021 opportunistic data was collected on board of a dolphin watching vessel in Faro, with observers logging cetacean’s reaction towards the boats. Both bottlenose dolphins and common dolphins were considered as target species in the present study. Results show that a higher number of boats is often associated with evasive reactions on both species, with considerably higher evasion rate on *Tursiops truncatus*. Specific research should be conducted in the area to determine the dolphin watching carrying capacity for those target species and assess the long-term effects of touristic vessels on local cetacean populations.

**Discovery of Sound in the Sea: 20 Years of Communicating Underwater Acoustics Research**

Kathy Vigness-Raposa¹, Gail Scowcroft², Holly Morin², Christopher Knowlton²

¹INSPIRE Environmental, Newport, RI, ²University of Rhode Island, Graduate School of Oceanography, Narragansett, RI

Twenty years ago, the *Discovery of Sound in the Sea* (DOSITS) Project launched an interactive website ([dosits.org](http://dosits.org)) that synthesizes peer-reviewed science related to underwater sound, including content on sound sources, potential impacts on marine life, and how animals and people use sound underwater. Guided by surveys of several stakeholder communities, the website has grown incrementally over the years to now include over 400 content pages, serving almost 3.5 TB of data with a lifetime page view count of close to 13 million. To continue addressing the information needs of decision makers, regulators, the scientific community, and the general public, the website is updated semi-annually with newly published information after a thorough review by a panel of scientific experts (much gratitude to the over 200 researchers that have provided DOSITS content over the years). High-need underwater acoustics content and associated resources have been identified through five surveys conducted in 2015-2021. Current
DOSITS Project activities include webinars, which consist of presentations by experts followed by real-time, interactive sessions, all of which are archived on the DOSITS website as a permanent resource. Webinars have been conducted from 2015-2021 on the science of underwater sound; sound production and reception by marine mammals; effects of sound on marine mammals; sound production and reception in teleost fishes; effects of sound on fishes; and sound sources, including wind turbines, pile driving, seismsics, echosounders, sonar, and shipping. In addition to the webinars, tutorials, instructional videos, and e-books have been developed to address content prioritized in the surveys, such as the fundamentals of acoustics, hearing sensitivities, and updates on potential effects of underwater sound on marine animals. This presentation will provide an overview of current DOSITS resources developed to address the DOSITS mission to increase understanding and awareness of science related to underwater sound.

**Reduction in the number of gray whale calves (Eschrichtius robustus) in Bahía Magdalena Complex, BCS, Mexico, 2016-2021**

Lorena Viloria Gomora¹, Mariana Hidalgo Reza², Rodrigo Huerta³, Omar Garcia⁴, Steven Swartz⁵, Jorge Urban⁶

¹Universidad Autonoma de Baja California Sur, La Paz, Baja California Sur, Mexico, ²Universidad Nacional Autónoma de México, La Paz, ³Centro de Investigación Científica y de Educación Superior de Ensenada, Ensenada, Baja California, Mexico, ⁴Universidad Autonoma de Baja California Sur, Mexico, ⁵Laguna San Ignacio Ecosystem Science Program, Darnestown, ⁶Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico

The lagoon complex integrated by Magdalena Bay, Almejas Bay, and Santo Domingo Chanel, on the west coast of the Baja California peninsula, Mexico, is the southernmost breeding area for the gray whale. In this area, the gray whales mate, give birth and take care of their calves. The Marine Mammal Research Program, UABCS, has been conducting censuses since 2012, but since 2016, it has allocated more effort to monitor this area. Between 2016 and 2021, 141 surveys were conducted, including 22 censuses along fixed routes. A photo identification catalog and a database associated with all records have been achieved. Data analysis of these six years showed a seasonal cycle in the number of calves during the winter season, i.e., a gradual increase from January, which reaches a maximum in February and decreases in March. Except for 2018, where the peak was reached in March. Furthermore, it revealed a dramatic decrease in the number of calves. 71% of the 307 calves registered in six years of monitoring were observed between 2016 and 2017. The annual number of calves change from 110 (± 20) on average per year in 2016 and 2017 to 22 (± 9) calves per year from 2018 to 2021. In other whale species, reproductive success depends on good body condition and foraging success, among other factors. Therefore, we consider reducing the number of calves in the lagoon complex related to the “skinny whale” syndrome (poor body condition), registered in the last four years (2018-2021).

**First humpback whale resighting from West Indies to Mediterranean Sea**

Biagio Violi¹, Alessandro Verga¹, Lindsey Jones², Giulia Calogero³, Giulia Soldano², Ted Cheeseman⁴, Frederick Wenzel⁶

¹Menkab, il respiro del mare, Genova, Italy, ²Golfo Paradiso Whale Watching, ³College of the Atlantic, ⁴Menkab: il respiro del mare, Varazze, SAVONA, Italy, ⁵Southern Cross University, ⁶Protected Species Branch, NOAA, NMFS, Woods Hole, MA

North Atlantic humpback whales breed in the West Indies and in the Cape Verde archipelago, and then migrate to feeding grounds of Gulf of
Maine, Newfoundland, Labrador, Gulf of St. Lawrence, West Greenland, Iceland, and Norway. This species is rare within the Mediterranean Sea and are currently classified as a ‘visitor’ species. Here we report on the occurrence of a female-calf pair in the Ligurian Sea in August 2020 and the first photographic recapture of the adult to the West Indies breeding ground. A photograph of the fluke has been compared with the North Atlantic Humpback Whale Catalog (NAHWC), including over 11,000 individuals from across North Atlantic (curated by Allied Whale at the College of the Atlantic), and with the Happywhale database, matched through automated image recognition of humpback whale flukes. The adult whale, identified as NA05503, was first photographed on the Silver Bank north of the Dominican Republic, on February 12th, 1986, the only known sighting of this individual for the past 34 years and 6 months. We observed no marked changes in the ventral fluke pattern, that suggest that the whale already was an adult during the first sighting.

The occurrence in late August may suggest use of the Mediterranean Sea and the Ligurian Sea as a feeding area. However, no feeding activity was observed and fat loss along the vertebral column and the blowhole region of the adult were reported. To date this is the second confirmed recapture with the North Atlantic. It is known that humpback whales complete large longitudinal movements especially in changeable or unpredictable circumstances, but it is unknown why this pair entered the Mediterranean. This resighting provides the first evidence of a breeding ground origin for a humpback documented in the Mediterranean Sea.

Where, when and why: modelling the distribution and habitat of deep-diving cetaceans incorporating variables depicting the deep oceanic layers

Auriane Virgili1, Valentin Teillard1, Ghislain Dorémus1, Tim E Dunn1, Sophie Laran1, Mark Lewis1, Maite Louzao6, José Martinez-Cedeira7, Emeline Pettex8, Leire Ruiz6, Camilo Saavedra10, Olivier Van Canneyt1, Jose Antonio Vazquez11, Vincent Ridoux1

1Observatoire Pelagis UMS 3462 LRUniv - CNRS, La Rochelle, France, 2Observatoire Pelagis UMS 3462 LRUniv - CNRS, La Rochelle, Nouvelle Aquitaine, France, 3Joint Nature Conservation Committee, Aberdeen, United Kingdom, 4Observatoire Pelagis UMS 3462 LRUniv - CNRS, La Rochelle, Nouvelle-Aquitaine, France, 5JNCC, Aberdeen, United Kingdom, 6AZTI Fundazioa, Pasaia, Spain, 7Coordinadora para o Estudio dos Mamíferos Maríños (CEMMA), Pontevedra, Spain, 8Cohabys, La Rochelle, France, 9AMBAR Society for the study and conservation of marine animals, es, 10Instituto Español de Oceanografía, Vigo, Spain, 11ALNILAM, Sabiñanigo, Huesca, Spain

The use of Species Distribution Models (SDMs) has increased considerably in recent decades, notably for conservation purposes. SDMs are used particularly to characterise and predict marine top predator distributions thanks to the use of surface dynamic environmental variables (easily accessible and available at various spatial and temporal scales) as proxies for prey distribution. For oceanic species that spend most of their time in depth waters like deep-diving cetaceans (here beaked whales and sperm whales), the use of surface variables may limit the ability to correctly infer their habitats through SDMs. We combine, static variables that characterise the topography of the bottom water and dynamic variables integrated over different depth classes that characterise the water column into Generalised Additive Models to model the distribution of deep-diving cetaceans in the Bay of Biscay and to identify which variables are the most important for each species. We obtained relationships with the environment that allow predicting the highest densities of beaked whales and sperm whales near the continental slope, near canyons and seamounts and in the abyssal plain.
of the Bay of Biscay. We also identified different responses between beaked whales, for which surface, subsurface and static variables were selected as the most important variables, and sperm whales. For the latter only surface and depth variables were selected, which could suggest differences in foraging strategies and in the prey targeted between these species. The continuous development of ocean models and the availability of depth variables, allows as we have shown, the improvement of the tools available for the planning of human activities, especially for species that would be closely linked to processes taking place in deep waters, such as top predators.

Individual variation in orca (Orcinus orca) tail fluke pigmentation as a tool for photo-ID

Ingrid Visser¹, Juan Copello², Jorge Cazenave², Tracy Cooper³
¹Orca Research Trust, Tutukaka, New Zealand, New Zealand, ²Punta Norte Orca Research, Chubut, Argentina, ³Wellington, New Zealand

The key to many long-term field studies of cetaceans has been the ability to uniquely identify individuals. Orca (Orcinus orca) were one of the first species to be recognised by researchers as having pigmentation that was distinguishable between animals and stable enough to enable long-term monitoring. Typically, the key pigmentation zones assessed for orca are; (1) the overall body pigmentation (black or grey), (2) saddle-patches (grey) and (3) the eye-patches (white). These three zones are useful when the animals are photographed in the traditional ‘side-on’ position, however, if the animals are moving away these features are not readily accessible to researchers. Nevertheless, the underside of tail flukes (typically white with black margins exhibiting unique pigmentation patterns) are occasionally presented during travel (or they may be visible during social interactions / foraging). We present a range of orca under-

Sensitivity and precision of Unoccupied Aerial System-photogrammetry to assess the age structure of delphinid populations

Fabien Vivier¹, Amanda Bradford², Marie Hill³, Erin Oleson³, Kym Yano³, Randall Wells⁴, Aude Pacini⁵, Eva Leunissen⁶, Cormac Booth⁷, Julie Rocho-Levine⁸, Lars Bejder⁹
¹Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, HI, ²Pacific Islands Fisheries Science Center, NOAA Fisheries, Honolulu, Hawaii, ³CIMAR/PIFSC/NOAA, Honolulu, HI, ⁴NOAA NMFS Pacific Islands Fisheries Science Center, Honolulu, Hawaii, ⁵CIMAR, NOAA Pacific Islands Fisheries Science Center, Honolulu, HI, ⁶Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, Florida, ⁷Hawaii Institute of Marine Biology, Kane’ohe, Hawaii, ⁸University of Otago, Dunedin, New Zealand, ⁹SMRU consulting, St Andrews, United Kingdom, ¹⁰Dolphin Quest, Honolulu, ¹¹Marine Mammal Research Program, University of Hawaii at Manoa, Hawaii Institute of Marine Biology, Kaneohe, Hawaii, HI

Understanding the health status of free-ranging wildlife populations is critical for the effective management of long-lived and slow-reproducing
species. Early detection of the effects of environmental and anthropogenic stressors on vital rates constitutes a powerful tool to forecast changes in population dynamics. For delphinid species, changes in demographic variables strongly correlate with changes in population growth. However, traditional monitoring approaches can take decades to detect these population-level changes. Thus, rapidly quantifying the age structure (e.g., the juvenile fraction) of free-ranging delphinid populations would be an informative metric evaluating population status, and may provide an early warning of future changes in a population’s abundance. Here, we test a new approach, the use of Unoccupied Aerial System (UAS)-photogrammetry, to rapidly monitor and detect changes in population age structure of small delphinids. First, the precision and accuracy of two UAS-photogrammetry platforms (Inspire 2 and APH-22) were tested to estimate body length (a proxy for age) at five altitudes (16-50m) for five male bottlenose dolphins (Tursiops truncatus) at Dolphin Quest Oahu, Hawaii, USA. Individual total body length (TL) was estimated using the blowhole-to-dorsal-fin-insertion length (BH-DF, a proxy measure for TL), when animals were surfacing. Results were then tested on a long-term dataset from bottlenose dolphins in Sarasota Bay, Florida to assess the sensitivity of UAS-photogrammetry to estimate age based on length of free-ranging individuals. Different age-classification scenarios with different age-class bins were tested. Across all altitudes, UAS-derived TL estimates were overestimated by 3.46 ± 1.12 % and 0.77 ± 1.08 % for the Inspire 2 and APH-22, respectively, when using surfacing BH-DF length measurements. Preliminary results indicate that UAS-photogrammetry allows for the correct age classification of calves, and most juveniles and adults. UAS-photogrammetry has the potential to be a powerful conservation tool to remotely assess age-structure for free-ranging delphinids.

Killer whale movements on the Norwegian shelf are associated with herring density

Emma Vogel¹, Erik Martin Biuw², Marie-Anne Blanchet¹, Ian Jonsen³, Evert Mul⁴, Espen Johnsen⁵, Solfrid Sætre Hjøllo², Morten Tange Olsen⁷, Rune Dietz⁸, Audun Rikardsen⁹
¹UiT - The Arctic University of Norway, Norway, ²Institute of Marine Research, ³Fjord-baelt / The Arctic University of Norway- UiT, Odense, ⁴Macquarie University, North Ryde, NSW, Australia, ⁵PhD candidate at UiT the Arctic university of Norway, Tromsø, Norway, ⁶Institute of Marien Research, ⁷Institute of Biology, University of Copenhagen, Copenhagen O, Denmark, ⁸Aarhus University, Roskilde, Denmark, ⁹The Arctic University of Norway-UiT, Tromsø, Norway

Killer whales Orcinus orca have a cosmopolitan distribution with a broad diet ranging from fish to marine mammals. In Norway, killer whales are regularly observed feeding on overwintering Norwegian spring spawning (NSS) herring Clupea harengus inside the fjords. However, their offshore foraging behavior and distribution is less well understood. In particular, it is not known to what degree they rely on the NSS herring stock when the herring move to deeper offshore waters. Satellite telemetry data from 29 male killer whales was analyzed to assess whether their offshore foraging behaviour is linked to herring distribution. Unlike most marine predator–prey studies that use indirect proxies for prey abundance and distribution, our study utilized two herring density estimates based on (1) direct observations from acoustic trawl survey data and (2) simulations from a fully coupled ecosystem model. Mixed effects models were used to infer the effect of herring density and light intensity on whales’ movement patterns. Our results suggest that killer whales follow NSS herring over more than 1000 km from their inshore overwintering areas to offshore spawning grounds. All whales changed from fast directed, to slow non-directed movement when herring density increased,
although individuals had different propensities towards movement. Our data indicated that whales continue to feed on herring along the Norwegian shelf. We conclude that NSS herring constitutes an important prey resource for at least some killer whales in the northeastern Atlantic, not only during the herring overwintering, but also subsequently throughout the herring spawning migration period.

Examining Fine-Scale Population Genetic Structure of Common Bottlenose Dolphins (*Tursiops truncatus*) in North Carolina Using Next-Generation RAD-Seq Data
Nicole Vollmer¹, Lynsey Wilcox², Antoinette Gorgone³, Aleta A. Hohn¹, Andy Read⁴, Eric Zolman⁶, Patricia Rosel⁷
¹University of Miami-CIMAS; NOAA/NMFS/SEFSC, ²NOAA Fisheries, Southeast Fisheries Science Center, Lafayette, LA, ³University of Miami-CIMAS, NOAA Fisheries Southeast Fisheries Science Center Beaufort, USA, Beaufort, North Carolina, ⁴NOAA/NMFS/SEFSC, Beaufort, North Carolina, ⁵Duke University, Beaufort, North Carolina, ⁶National Marine Mammal Foundation, San Diego, California, ⁷NOAA Fisheries, Lafayette, Louisiana

In the waters of North Carolina on the east coast of the United States, four management stocks of common bottlenose dolphins (*Tursiops truncatus*) are thought to occur, largely based on photo-identification and satellite telemetry data. Two stocks remain primarily within estuarine habitats throughout the year, and two inhabit coastal waters and are thought to make broadscale migratory movements in and out of state waters. Thus, the spatio-temporal overlap of these four stocks in North Carolina varies seasonally, creating a complicated stock structure where boundaries are difficult to identify, and the degree of demographic independence among populations is not well-understood. Furthermore, incidental mortality and serious injury of dolphins occurs in some fisheries in North Carolina, but the spatio-temporal overlap makes it difficult to assign mortalities and characterize their impact on each stock. We obtained biopsy samples from 142 individuals and investigated the genetic population structure of dolphins in these waters using next-generation molecular sequencing techniques and a reference genome-based alignment, producing a data set of over 5,000 single nucleotide polymorphism (SNP) markers. Using this highly informative data set, Bayesian structure analysis identified four significantly differentiated populations (overall $F_{ST} = 0.04, p < 0.0001$). However, the distributions of these populations do not align well with the currently delineated stocks, and genetic data support the presence of three unique populations in estuarine waters of North Carolina. An improved understanding of the underlying population structure of common bottlenose dolphins in these waters will provide a better characterization of stock distribution and support more accurate assignment of mortality, which is imperative for successful conservation and management of this species.

Blue whale body condition from photographs taken over a 14-year period in the NE Pacific: Annual variations and connection to measures of ocean productivity
Rachel Wachtendonk¹, John Calambokidis², Kiirsten Flynn³
¹Universidade do Algarve, ²Cascadia Research Collective, Olympia, ³Cascadia Research Collective, Olympia, Washington

Large marine mammals can serve as an indicator of the overall state of the environment due to their long lifespan and apex position in marine food webs. Reductions in prey, driven by changes in environmental conditions can have resounding impacts on the trophic system as a whole, this can manifest in reduced fat stores that are visible on large whales. Poor health can lead to reduced survivorship and fitness, both of
which can be detrimental to a recovering population. We used a non-invasive technique for monitoring blue whale health and whether it changes with ocean conditions. Digital photographs of blue whales taken in the NE Pacific from Cascadia Research and collaborators from 2005-2018 (n=3,545) were scored for overall body condition based on visible vertebrae and body shape on a scale of 0-3 where a score of 0 indicated best body condition and a score of 3 indicated poorest. We tested whether there were patterns in the health of whales across years and whether overall poor health was related to oceanographic conditions and predictors of prey abundance on the California coast. Year was a highly significant factor in body condition (Chi-Square, p<0.001). The proportion of whales showing poor body condition (scores 2 & 3) overall was 33% but by year varied widely from a low of 18% (2008) to a high of 55% (2015). The only two years where >50% of animals had poor body condition were 2015 and 2017 (no other year was above 45%). The 2015 maximum proportion of whales in poor body condition coincide with the marine heat wave that affected the NE Pacific 2014-16 and impacted other whale populations. This indicates our scoring method was an effective way to evaluate blue whale health and how they respond to a changing ocean.

Assessing the Behavioral Response of Arctic Seals to Survey Aircraft

Skyla Walcott1, Irissa Danke2, Erin Moreland3, Paul Conn4, Peter Boveng4
1CICOES, NOAA, Seattle, 2University of Washington, NOAA, 3Marine Mammal Lab / NOAA, Seattle, Washington, 4Marine Mammal Lab / NOAA, Seattle, WA

Aerial surveys equipped with high resolution cameras are a common method used to estimate the species type, age class, abundance and distribution for a variety of marine mammals. However, aircraft disturbance can impact abundance estimates and have important permitting implications. In order to understand the behavioral impact to ice-associated seals during aerial surveys, a FLIR SAFIRE infrared camera was nose-mounted to the NOAA N56RF Twin Otter during the 2021 Joint Beaufort Sea Surveys (JoBSS). The aim of this study was to record the behavior of resting ringed seals (Pusa hispida) and bearded seals (Erignathus barbatus) ahead of the aircraft, and assess movements and behavioral changes as the aircraft passed over target species. The JoBSS survey occurred in the spring of 2021 across the Beaufort Sea. When weather conditions allowed, video trials were recorded of seals resting on the sea-ice before, during and after the aircraft overpass. Collectively, 161 trials were recorded of 287 individual animals (n= 266 ringed seals, n=21 bearded seals). Bearded seals were solitary, or within mom-pup pairs. Ringed seals were also often solitary, but could be found in groups as large as 31. As predicted, seals exhibited a range of reactions to the approaching aircraft. Across the study, only one bearded seal flushed (a young pup). However, 47.8% of all ringed seals flushed. Of those ringed seals, 48.1% flushed within the boundaries of the survey swath, most of which were before the plane passed overhead (92.3%). Flushing rates were modeled against explanatory variables such as group size, weather conditions, aircraft altitude and distance from the flight path. GLM findings determined that smaller groups that were further from the flight path were less likely to flush. This information is directly applicable to current population models, and can be used to assist in activity permitting in the high Arctic.

Humpback whale song in the framework of human music: rhythm and the fundamental rules of organization

Lisa Walker1, Fred Sharpe2
1Grooved Whale Project, Vancouver, BC, 2Alaska Whale Foundation, Seattle, WA
The sonic prowess of the humpback is evinced by the animal’s signal diversity, syntax, song evolution, and cultural revolutions. Five decades of inquiry have provided much insight, yet we remain in the dark concerning the humpback’s encoding of information and which song attributes target potential mates, rivals or collaborators. This impasse has led to notions of song evolution via embellishment, inviting further techniques adapted from the analysis of human music. Our goal is to extend theories of humpback song as a mechanism of group cohesion. Music, defined as a form of humanly organized sound, is based on the generation of temporal and melodic regularities with patterns composed from complex rules and relationships. Rhythm, defined as patterns in time, is the central organizing construct of human music. Music can exist without melody but not without rhythm. Taking our cue from the structural foundations of music, we disentangle whale song rhythms into their constituent components and quantitatively define each property. We then search for similarities across songs, years and populations. Our findings reveal the presence of scalable, modular building blocks across singers and songs. This reuse and reiteration of building blocks suggests whale song at the rhythmic level may be better understood as variations on a theme rather than progressive and non-reversible. Evidence of a rhythmic syntax raises questions of rhythm’s origin and function in whale song. We review rhythm’s origin in our own species, the role it plays in our music, culture and identity and the cognitive capacity required for its generation. We demonstrate human music is an appropriate framework for whale song analysis and recommend its methodologies for further inquiry.

Since the 1980s, National Park Service staff have been contributing to a database of population counts for northern elephant seals (*Mirounga angustirostris*) at Point Reyes National Seashore (PRNS) in Marin County. In 2016, a group of Dominican University students began contributing to the database by surveying major haul out sites in PRNS. These subsites included Drakes Beach, South Beach, and Point Reyes Headlands. The total number of seals gender, age class and weather conditions were collected weekly at each haul out site under PRNS permits. Data from 2009 to 2019 were used to analyze the relationship between pupping sites through time. Recent changes and the effects of multiple El Niño years on pupping sites were observed. A series of natural phenomena have shifted the number of individual seals pupping at each of the main sites previously mentioned. The objective of this student case study is to use northern elephant seals as a model to track and quantify the change in behavior due to climate change.


Amanda Warlick¹, Gina Himes Boor², Tamara McGuire³, Kim Shelden⁴, Eiren Jacobson⁵, Charlotte Boyd⁶, Paul Wade⁷, Andre Punt⁸, Sarah J. Converse⁹

¹University of Washington, Seattle, ²Montana State University, Bozeman, Montana, ³Aqua Wildlife Research, Anchorage, AK, ⁴Alaska Fisheries Science Center, Seattle, Washington, ⁵University of St Andrews, St Andrews, Fife, United Kingdom, ⁶University of Washington, Seattle, WA, ⁷National Marine Mammal Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, ⁸School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA, ⁹USGS WA Cooperative Fish and Wildlife Research
The beluga (*Delphinapterus leucas*) population in Cook Inlet, Alaska, USA is estimated to have declined by 75 percent over two decades and is listed as Critically Endangered on the IUCN Red List. Substantial monitoring effort and resources have been invested to conduct aerial and mark-resight surveys, yet considerable uncertainty still remains about demographic rates and potential factors limiting recovery. One way to improve our understanding of population dynamics and viability is through integrated population modeling, where multiple sources of information are combined to reduce bias and improve precision. We use aerial survey data and mark-resight observations of mother-calf pairs from 2005-2017 in a Bayesian integrated population model to estimate interannual variability in stage-specific survival, reproductive rates, and abundance while accounting for uncertainty in female reproductive state and age at first reproduction, filling a critical gap in knowledge for this population. Using this framework, we conducted a population viability analysis to estimate quasi-extinction risk and the sensitivity of population dynamics to changes in demographic rates. We review model results that indicate notably low adult survival at times during the study period, a recent period of decreasing abundance, and projected quasi-extinction rates over the next 100 years. We show how this framework can be used to evaluate hypotheses about intrinsic or extrinsic factors that may be limiting recovery and what conservation actions could ameliorate the effects of the most impactful anthropogenic stressors. Our findings highlight the utility of integrated modeling for capitalizing on all available information to reduce uncertainty and inform conservation of a depleted, geographically-isolated population.

Exploring habitat selection as a driver for foraging differences in grey and harbour seals

*Kara Watts¹, Sophie Smout², Magda Chudzinska³*

¹Disney's The Seas at Epcot, ²University of St Andrews, Sea Mammal Research Unit, St Andrews, United Kingdom, ³University of St Andrews, St Andrews, United Kingdom

Grey (*Halichoerus grypus*) and harbour seals (*Phoca vitulina*) are sympatric species which exhibit distinct foraging behaviours. The foraging ranges of both species overlap significantly with most trips occurring less than 50 km from their haulout. However, while harbour seals rarely exceed 50 km, grey seals commonly travel up to 100 km from haulout. Building from the harbour seal agent-based model, AgentSeal, we developed AgentGrey to simulate the foraging behaviours of grey seals outside of their breeding and moulting seasons. Parameters for body size, prey selection, food intake, digestion, and habitat use were adjusted within AgentSeal to explore their effects on modelled seal behaviour. We tested each parameter incrementally to quantify the effects influencing the foraging ranges, food intake, and growth of modelled seals. The model was validated for behavioural accuracy using telemetry data from grey seals tagged in Eastern Scotland. Through the development of this model, we explored the physiological and ecological differences between both species as it attributed to their distinct foraging habits. We found that habitat preference and prey abundance had the largest impact to increase modelled foraging areas. Increasing body length, mass, and blubber reserves equivalent to grey seal sizes only increased the foraging range limits significantly when presented with harbour seal habitat preferences. These findings suggest that grey seal foraging behaviours are tied more closely to ecological factors and mediated by physiological advantages. AgentGrey provides a platform from which we can expand our understanding of grey seal habitat use. As a
fundamental ecological question, understanding what drives the distinct foraging behaviours between two sympatric seal species can add to the discussion of how they may have adapted to their environments and may suggest how environmental changes influence their behaviour.

Ecological Rubik’s Cube: Two Case Studies of Shark Bite Healing Rates of Free-ranging Bottlenose Dolphins, Tursiops truncatus

Ann Weaver¹, Jennifer Bloodgood²  
¹John’s Pass Dolphin Study, Good-natured Statistics Consulting, St Petersburg, FL, ²Dauphin Island Sea Lab, Dauphin Island, Alabama

The technical and popular literature attributes remarkable healing powers to bottlenose dolphins. Yet data are lacking. Healing processes among captive cetaceans are potentially modified by chemically-treated water in holding pools, medications, handling, diet, etc. Healing processes at sea remain poorly documented because ranging patterns often produce sightings that are too infrequent to contribute systematic knowledge. During 17 years of intensive ethological study of free-ranging bottlenose dolphins in a west central Florida estuary (N=1612 surveys), healing rates following 82 incidents of fresh or recent shark bites were photo-documented. Two case studies are presented, providing rates and descriptions of inflammatory, repair, and maturation wound-healing stages visible to boat-based observers based on photographic evidence. Case study 1: yearling dolphin bitten 10 times in a single shark encounter; researchers witnessed the attack. Because bite time was known, the next 84 sightings (to date) provided a bi-weekly exemplar of healing stages, starting with temporal sequence of blubber expansion launched 5 minutes after the attack through scar formation by 90 days, with eventual restoration of background pigmentation but limited restoration of body contouring. Case study 2: adult female bitten repeatedly across an accelerating sequence of separate encounters spanning years suggesting that aging dolphins may become more susceptible to wounding from shark encounters over time (N=438 sightings). The most recent bite provided healing details on her unexpected recovery from a severe degloving injury caudal to the blowhole. Healing rates in free-ranging dolphins are important because increasing marine pollution (noise, turbidity, vessel traffic) puts marine mammals and their habitats under increasing stress. Sufficient knowledge on healing rates can inform boat-based observers of baseline interspecific interactions between top predators and potentially reveal changes as the ecological balance is continually compromised by anthropogenic activities.

Northern and western records for the Guadalupe fur seal and a summary of its distribution

Marc Webber¹, Deborah Boege Tobin¹, Sue Pemberton¹, Courtney N. Pace¹  
¹The Marine Mammal Center, Woodstock, IL, ²University of Alaska, Kachemak Bay Campus, Homer, Alaska, ³California Academy Of Sciences, San Francisco, ⁴Alaska SeaLife Center, Alaska

Guadalupe fur seals (Arctocephalus philippi townsendi), now considered part of the Juan Fernandez fur seal complex, suffered severe population depletion from sealing. A small number survived at Isla Guadalupe, and they are rapidly recovering and re-inhabiting their former range, including a breeding colony at Islas San Benitos, and an incipient colony in the Gulf of California at Isla Las Animas, all in Mexico. Guadalupe fur seals are once again part of the pinniped fauna from California to Washington and found widely in central and southern Mexico. We present three new records from Alaska that establish the northern and westernmost occurrences for the subspecies: 1) A
sub-adult male in good condition came ashore at a northern fur seal (Callorhinus ursinus) rookery on Saint Paul Island in the Bering Sea sometime between 1-5 July 1998. Scott Buckel, a visiting birder, posted his photographs to the iNaturalist citizen scientist online app in 2018; 2) A juvenile male rescued in poor condition from Kachemak Bay on 28 July 2007. The Alaska SeaLife Center and The Marine Mammal Center collaborated on rehabilitation and it was later released in California; 3) An adult/sub-adult female in moderate condition hauled-out for part of one day at Priest Rock, Unalaska Island in the Aleutians on 25 March 2014. The source of the discovery was a photograph published by Bret Richardson of Dutch Harbor in a travel guide to Unalaska. The 1998 Saint Paul and 2014 Unalaska records occurred during El Niño warming events of 1997-1998 and 2014-2015. The Unalaska sighting was also coincident with the first year of the unprecedented North Pacific marine heatwave of 2014-2015. Plausibly, these two records can be related to unusually elevated sea surface temperatures. Recent records of Guadalupe fur seals from the Gulf of California to the Galapagos Islands are also reviewed.

First record of California coastal bottlenose dolphins in northern California offshore waters

Isidore Szczepaniak1, Bill Keener2, Marc Webber3, Tim M Markowitz4, Amanda Spears5, Mark Cotter6, Allison Payne7, Bekah Lane4

1The Marine Mammal Center, Corte Madera, CA, 2Marine Mammal Center, Corte Madera, California, 3The Marine Mammal Center, Woodstock, IL, 4The Marine Mammal Center, Point Blue Conservation Science, Petaluma, CA, 5UMass Dartmouth, Virginia Beach, VA, 6San Francisco State University, Golden Gate Cetacean Research, Dana Point, California

Two distinct ecotypes of bottlenose dolphins (Tursiops truncatus), differentiated by morphology and genetics, inhabit the nearshore waters of California: a coastal form typically <1 km from shore in depths of 10-30 m and an offshore form found in deeper waters, usually more than a few km from shore. Until 1982, the coastal bottlenose dolphin stock was limited to the Southern California Bight, but extreme weather events and climate change resulted in their range expansion, bringing them north to the San Francisco Bay Area by 2007. Currently, 105 individual coastal bottlenose dolphins have been photo-identified in this area. On 18 March 2019, three of these coastal bottlenose dolphins were photographed from Southeast Farallon Island, 43 km west of San Francisco. The dolphins, TMMC #21 (Akeakamai), TMMC #22 (Tikawana) and TMMC #31 (Oreo) were observed circumnavigating the island for several hours that day. Akeakamai and Tikawana were sighted back in their regular coastal habitat a few weeks later on 4 April 2019, while Oreo has yet to be re-sighted. Prior to the Farallon event the three dolphins had a history of multiple sightings restricted to the mainland coast of northern and central California. Their occurrence at Southeast Farallon Island represents the farthest offshore record for California coastal bottlenose dolphins. Depending on their route from the mainland, these dolphins traveled across the Gulf of the Farallones between 32-43 km through waters 55-84 m deep. Previously, coastal bottlenose dolphins in Southern California were known to range up to 15 km offshore. Our results confirm that this flexible top marine predator explores novel habitat, and the stock’s recent emigration to the San Francisco Bay Area presents ecological opportunities. It is also a reminder that care should be taken when assigning bottlenose dolphins to ecotype based solely on their occurrence in nearshore versus offshore waters.
Investigating the behavioral, social, and environmental context of sound in the foraging strategies of humpback whales (Megaptera novaeangliae)
Sarah Weiss¹, David Wiley², Susan E Parks³
¹Syracuse University, ²Stellwagen Bank National Marine Sanctuary, NOAA National Ocean Service, Scituate, MA, ³Syracuse University, Syracuse, New York

Humpback whales are known for the plasticity and variable nature of their acoustic communication, social interactions, and foraging behaviors. Distinct foraging strategies are used to capture different prey types at the surface and on the seafloor. Sounds produced during foraging are thought to facilitate intraspecific social communication. Previous studies have identified specific sound types produced by humpbacks associated exclusively with benthic foraging strategies, suggesting functions related to foraging behavior. In this study, we use suction cup acoustic tags (DTAGs) deployed on humpbacks in the western North Atlantic from 2017-2019 to investigate sound production associated with humpback foraging ecology, distinguishing three distinct sound types used across different foraging strategies: the paired burst bout, thwop, and bark sequence. We assess the behavioral, social, and environmental context of sound and present an analysis of the acoustic variations between surface and bottom foraging behavior across 25 individual whales. Preliminary results suggest that these call types serve a social communication function as opposed to prey manipulation, as all three call types were found to occur in both foraging and non-foraging behaviors. In particular, thwops and bark sequences were found to occur most commonly during non-foraging behaviors, with relatively equal presence in bottom foraging compared to surface foraging behaviors. These findings will advance knowledge of humpback foraging behaviors, furthering understanding of the behavioral and acoustic plasticity used to adapt foraging to a changing environment. Additionally, the ability to determine behavioral state and foraging strategy based on the sounds vocalized has important implications for future management strategies.

Exploring Intra- and Inter-specific Variations of Dolphin Whistles via Unsupervised Feature Learning
Anita Weng¹, Tzu-Hao Lin², Hsin-yi Yu³
¹University of Michigan, Tainan, Taiwan, ²Biodiversity Research Center, Academia Sinica, Taiwan, ³Institute of Ecology and Evolutionary Biology, National Taiwan University, Taiwan

Narrowband, frequency-modulated whistles play an indispensable role in the acoustic communication of dolphins and whales, as they can convey information associated with species identities and behavioral contexts. However, the complexity of whistle usage has elevated the difficulty in quantifying species-specific whistle repertoires. Here we utilized a local-max detector and sparse nonnegative matrix factorization to extract dolphin whistles, replacing traditional methods of contour extraction that require an extensive amount of manual effort. With this automated method, we were able to largely streamline the analysis of whistle variability and generate a dictionary of whistle features from sound recordings of 7 delphinid species. Dimension reduction of the whistle features using Uniform Manifold Approximation and Projection helped us visualize the diversity and divergence of whistle usage among species. We were also able to use the species-specific whistle usage patterns to classify the 7 delphinid species, with a performance of around 0.83. The proposed method establishes a way to efficiently extract essential components from the entire repertoire of dolphin whistles, build feature dictionaries for respective species, assess inter- and intra-specific variations of whistle usage, and classify species with minimal supervision. Our results demonstrate its potential give us insight into the mechanisms of dolphin communications.
Inferring Movements of Northern Bottlenose Whales from Photographic Information and Long-term Passive Acoustics

Paul Wensveen1, Barbara Neubarth2, Andreas Macrander3, Patrick Miller4, Frans-Peter Lam5, Hólmfríður Jakobsdóttir6, Jörundur Svavarsson7
1Faculty of Life and Environmental Sciences, University of Iceland, Reykjavik, Capital Region, Iceland, 2University Centre of the Westfjords, Iceland, 3Marine and Freshwater Research Institute, Iceland, 4Sea Mammal Research Unit, School of Biology, University of St Andrews, St Andrews, Fife, United Kingdom, 5Acoustics & Sonar, TNO, The Hague, Netherlands, 6University of Iceland, Iceland, 7Faculty of Life and Environmental Sciences, University of Iceland, Reykjavík, Iceland

The commercial exploitation of the northern bottlenose whale (Hyperoodon ampullatus) throughout its range in the 19th and 20th centuries severely reduced its numbers and likely continues to provide challenges to its recovery. However, population assessments are severely hampered by a general lack of understanding about the stock structure, migration patterns, critical habitat and potential threats of northern bottlenose whales. Here, we present the first results of HYPMO, a research project on Hyperoodon ampullatus’ movement ecology and vulnerability to man-made noise exposure. Photographic materials collected by researchers and naturalists in the Jan Mayen-Iceland-Faroe Islands region since 2007 were analysed to establish a catalogue of individuals, collate their sighting histories, and assign individuals to age-sex classes. In addition, several deep-sea moored hydrophones were deployed at ~1500-2500 m depth in areas with steep bathymetries to the east and northeast of Iceland. The photo-ID catalogue for left-side photos currently holds a total of 283 individuals of which 173 have high distinctiveness (right sides: total 315, high distinctiveness 145). Age-sex classification as well as previous genetic sexing indicated a high percentage of whales encountered around Jan Mayen were female. Preliminary analysis of the acoustic data revealed the occurrence of echolocating northern bottlenose whales in the area. Temporal patterns in the acoustic occurrences over these deployments were consistent with information from satellite tags, stranding patterns and passive acoustics from Jan Mayen suggesting seasonal migrations of northern bottlenose whales in the northeast Atlantic, including between Jan Mayen and Iceland. Future research within the HYPMO project will be discussed.

Functional morphology of pygmy right whale feeding: a striking case of convergent evolution

Alexander Werth1, Catherine Kemper2, Anton van Helden3, Felix Marx4, R. Ewan Fordyce5, Matthew McCurry6, Travis Park7, David Hocking8, Alistair Evans9, Erich Fitzgerald9, Sentiel Rommel10, James G. Mead11, Joy S. Reidenberg, Ph.D.12
1Hampden-Sydney College, Hampden-Sydney, Virginia, 2South Australian Museum, Adelaide, Australia, 3Department of Conservation New ZealandNEW ZE, Wellington, New Zealand, 4Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand, 5University of Otago, Dunedin, New Zealand, 6Australian Museum, Sydney, Australia, 7Natural History Museum, London, United Kingdom, 8Monash University, Melbourne, Australia, 9Museums Victoria, Melbourne, Australia, 10University of North Carolina Wilmington, Wilmington, NC, 11Washington, DC, 12Icahn School of Medicine at Mount Sinai, New York, New York

Pygmy right whales, Caperea marginata, are the smallest and least known living mysticetes. Formerly classified with “true” right whales (Balaenidae), Caperea is the sole member of Neobalaenidae, although some see it as a relict lineage of the otherwise extinct Cetotheriidae (Early Miocene–Early Pleistocene). We present details from dissections of multiple specimens of
all age classes and explain these in relation to the rarely documented instances in which pygmy right whales have been observed alive. Even though molecular and morphological analyses place *Caperea* as a sister to rorquals and gray whales, many aspects of pygmy right whale anatomy are unlike those of balaenopteroids and instead strikingly similar to right whales, suggesting remarkable evolutionary convergence. Among numerous derived (apomorphic) features shared with balaenids are the arched rostrum, keeled palate, fully fused neck, semicircular lips, and relatively long baleen, with numerous fine (0.12 mm thick), dense (113/cm) fringes. *Caperea*’s mandible is unique among mysticetes, but its jaw joint is like that of balaenids, as is its firm, elevated tongue; however, the synovial TMJ and large, muscular tongue are presumed symplesiomorphies for Mysticeti. Muscles of the jaw, tongue, hyoid, and gular region are similar to both balaenids and balaenopteroids and largely symplesiomorphic. We conclude that pygmy right whales, like bowhead and right whales, display numerous morphological, biomechanical, and ecological adaptations to skim feed, both alone and in groups at the surface and deeper in the water column, on copepods, krill, and other small zooplankton. Nonetheless, in several key aspects of feeding ecology, an equally good analogue for *Caperea* may be the sei whale, *Balaenoptera borealis*, which rapidly skims plankton in shorter bouts than the typically slow, extended-duration, continuous filtration of balaenids. Therefore, although pygmy right whales exhibit strong structural convergence with balaenids, they likely show better functional convergence with sei whales.

Novel cetacean morbillivirus in a rare Fraser’s dolphin (Lagenodelphis hosei) stranding from Maui, Hawai‘i
Kristi West¹, Ilse Silva-Krott², Nelmarie Landrau-Giovannetti³, David Rotstein⁴, Jeremiah Saliki⁵, Stephen Raverty⁶, Ole Nielsen⁷, Vsevolod Popov⁷, Nicole Davis⁸, William Walker⁹

¹University of Hawaii, Kaneohe Bay, HI, ²Annandale, Virginia, ³University of Florida, Gainesville, FL, ⁴Marine Mammal Pathology Services, Olney, Maryland, ⁵University of Georgia, Athens Veterinary Diagnostic Laboratory, Athens, Georgia, ⁶The Animal Health Center, Abbotsford, British Columbia, ⁷Department of Fisheries and Oceans (DFO) Canada, Winnipeg, MB, ⁸NOAA Fisheries Pacific Islands Regional Office, Kihei, HI

Morbillivirus is recognized as one of the greatest infectious disease threats to cetaceans worldwide with a unique strain, Beaked whale morbillivirus (BWMV), previously identified from stranded Hawaiian cetaceans. We present findings associated with a novel cetacean morbillivirus identified from a Fraser’s dolphin that stranded in Maui, Hawaii in 2018 that is dissimilar to BWMV and other known strains. Abnormalities in the lung, lymph nodes and liver were observed during the gross necropsy and histopathological findings included intranuclear inclusions in bile duct epithelial, lymphoid depletion, rare syncytial cells in the lung, and syncytial cells and non-suppurative meningitis. Immunohistochemical staining using a morbillivirus genus cross-reactive anti-CDV monoclonal antibody demonstrated the presence of morbilliviral antigen in the cerebrum, cerebellum, spleen, lung, kidney and lymph nodes. Cerebellum and lung tissue homogenates were inoculated onto Vero.DogSLAMtag cells for virus isolation and cytopathic effects were observed, resulting in the formation of multinucleated giant cells (i.e., syncytia). Transmission electron microscopy of infected cell cultures also revealed syncytial cells with intracytoplasmic inclusions of viral nucleocapsids, consistent with the ultrastructure of a morbillivirus. Samples of the cerebellum, lung, liver, spleen and lymph nodes were positive for morbillivirus using a reverse transcription-polymerase chain reaction. The resulting 559 bp L gene sequence had the highest nucleotide identity (77.3%) to porpoise morbillivirus from
Northern Ireland and the Netherlands. The resulting 248 bp P gene fragment had the highest nucleotide identity to porpoise morbillivirus in Northern Ireland and the Netherlands and to a strain from a stranded Guiana dolphin (*Sotalia guianensis*) in Brazil (66.9%). As Fraser’s dolphins are a pelagic species that infrequently strand and are rarely sighted nearshore in Hawaii, a novel strain of cetacean morbillivirus may be circulating in the central Pacific that could have additional population impacts through transmission to other small island-associated cetacean species in this region.

Acoustic detections of sperm whales in the western North Atlantic: insights into their foraging ecology and abundance

**Annabel Westell¹**, Taiki Sakai², Robert Valtierra³, Sofie Van Parijs³, Danielle Cholewiak⁴, Annamaria DeAngelis⁵


Sperm whales are listed as endangered under the Endangered Species Act, making it imperative that we understand population trends in abundance and distribution. Passive acoustic line-transect surveys significantly improve the detection of sperm whales by increasing the detection range and likelihood of recording submerged whales. In the western North Atlantic Ocean efforts are underway to couple acoustic and visual data, however these methods discount sperm whale depth based on the assumption that it has a negligible effect on abundance estimation. Between June 27 and August 25, 2016, the Northeast Fisheries Science Center (NEFSC) completed a broad-scale cetacean abundance survey along the U.S. east coast. Approximately 6600 km of simultaneous visual and passive acoustic line-transect surveys were conducted from the NOAA ship *Henry B. Bigelow*. More than 350 hours of acoustic recordings, collected over 40 days using a towed linear hydrophone array, were analyzed using PAMGuard 2.01.03. Sperm whales producing foraging clicks were detected 687 times. The number of clicks detected in a click train ranged from 7 to 4628 (median = 288 clicks), and duration ranged from less than one minute to more than 60 minutes (median = 8.4 minutes). For all but 13 click trains, the slant range of the whale to the array was calculated using Target Motion Analysis’s 2D Simplex Optimisation algorithm. Using the method in DeAngelis et al. (2017), we will estimate the dive depth for clicks with multipath reflections and correct the slant ranges to horizontal perpendicular distances. These data will then be used to estimate a detection function and abundance, and results will be compared to the same data without correcting for depth. This project presents an innovative and effective approach for using passive acoustics to better understand the abundance, distribution, and ecology of the western North Atlantic sperm whale population.
to have low levels of compliance with the mandatory speed rule, particularly off Savannah, Georgia, and New York, New York. Successful compliance and cooperation with right whale mandatory and voluntary vessel-speed measures require vessel operators’ awareness and comprehension. We used social science to investigate these operators’ awareness, comprehension, compliance, and cooperation with the vessel-speed measures. Our research design borrowed from the fields of marketing and environmental psychology to illuminate why people choose to comply or not with speed rules. The study objectives were to: (1) better understand the factors that motivate compliance within this vessel operator community, (2) assess the effectiveness of various education and outreach methods/tools used to reach this community, and (3) determine if there are more applicable and effective communication and/or outreach methods/tools to enhance compliance with mandatory speed restrictions and cooperation with voluntary speed recommendations. The results of this study will assist NOAA Fisheries in developing future education and outreach efforts for vessel-speed reduction measures.

Environmental DNA assay for detection of the rare Rice’s whale in the Gulf of Mexico
Lynsey Wilcox¹, Nicole Vollmer², Laura Aichinger Dias³, Anthony Martinez⁴, Patricia Rosel⁵
¹NOAA Fisheries, Southeast Fisheries Science Center, Lafayette, LA, ²University of Miami-CIMAS; NOAA/NMFS/SEFSC, ³CIMAS/UM, NOAA/SEFSC, Miami, Florida, ⁴Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL, ⁵NOAA Fisheries, Lafayette, Louisiana

Rice’s whale (Balaenoptera ricei; formally the Gulf of Mexico Bryde’s whale) is the only resident baleen whale species in the Gulf of Mexico (GOMx). Most sightings of this whale are in the northeastern GOMx; however, historical whaling records suggest they may have inhabited the north-central GOMx, and recent acoustic and visual observation data have detected this species’ presence in the northwestern GOMx. Recently, non-invasive molecular genetic techniques have been developed to detect the presence/absence of species through the use of environmental DNA (eDNA). We evaluated the use of eDNA to detect this rare species to better understand its distribution outside its core habitat. We developed a new PCR-based assay targeting a small (89 bp) fragment of the mitochondrial DNA control region to detect eDNA shed by Rice’s whales in seawater. During a 2018 research cruise, seven water samples were collected in or near the “flukeprint” of whales. All samples collected in the vicinity of a whale were positive for Rice’s whale eDNA, while control water samples were negative, illustrating the efficacy of the new assay. During additional sampling in 2019 (n=26), we were able to further compare and optimize various collection methods such as filter pore size and storage medium. We also tested the ability to detect Rice’s whale eDNA at different time intervals after a whale surfaced and were able to detect eDNA as much as 10 minutes later. Taken together, data from these sampling events will help to refine and improve eDNA collection techniques in the lab and field for many marine mammal species. Furthermore, future eDNA work on Rice’s whales, including combining the newly developed assay with an autonomous environmental water sampler in the western GOMx, will improve our understanding of the distribution and habitat use of this endangered and elusive species.

Movement and diving behavior of satellite-tagged male sperm whales in the Gulf of Alaska
Lauren Wild¹, Russel Andrews², Jan Straley³, Franz Mueter⁴

¹NOAA Fisheries, Southeast Fisheries Science Center, Lafayette, LA, ²University of Miami-CIMAS; NOAA/NMFS/SEFSC, ³CIMAS/UM, NOAA/SEFSC, Miami, Florida, ⁴Southeast Fisheries Science Center, NOAA Fisheries, Miami, FL
Male sperm whales (*Physeter macrocephalus*) are known to depredate commercial longline fishing gear targeting sablefish (*Anoplopoma fimbria*) in the Gulf of Alaska (GOA). However, little is known about their movement patterns and diving behavior in this region, and how it is influenced by depredation. Our goals in this study were to better understand sperm whales’ use of space in the GOA and explore their diving behavior. Between 2007 and 2016 a total of 33 satellite tags were deployed on sperm whales interacting with fishing vessels, a subset of which also collected dive characteristics. We used state space models to interpolate hourly positions from tags, and additive models to explore environmental characteristics influencing dive behavior. Of the full tag data set, 29 tag records were usable in this analysis, 14 of which had associated dive information. Minimum rates of horizontal movement were much lower (1.4 km/hr) in GOA waters than south of the GOA (5.5 km/hr), indicating tagged whales sped up when they left the GOA. Behavioral states indicated primarily foraging behavior (82% of locations) in the GOA and primarily transiting behavior (74% of locations) when whales left the GOA heading south. Generalized additive models indicated that dives were significantly deeper and longer during the daytime than dusk, or nighttime, and dives were significantly deeper and shorter during quarter moons, when tidal currents are weakest. Maximum dive depth decreased in areas of higher sablefish CPUE, and decreased as seafloor depth increased, up to seafloor depths of 800 m, at which point dives became deeper with increasing seafloor depths. Our results show potential links between diving behavior and depredation behavior, and highlight the importance of the GOA continental slope as a foraging ground for these individuals.

We provide new insights into the diving behavior and movement of male sperm whales in a high latitude foraging ground.

Large whale entanglements in fishing gear or marine debris are a global and growing problem that interferes with vital life functions,
potentially causing serious injuries or death to individual whales. Entanglements also significantly impede population recovery of endangered species, and have been implicated as a major factor in the decline of North Atlantic right whales (*Eubalaena glacialis*) and the ongoing Unusual Mortality Event that the species is experiencing. NOAA Fisheries’ Marine Mammal Health and Stranding Response Program (MMHSRP) oversees the United States National Large Whale Entanglement Response Network (Network), which conducts response operations to remove entanglements, document how whales are entangled, and/or identify entangling gear. The MMHSRP works with our partners to track, monitor, and respond to entangled whales to assist the animals and better understand the scope and nature of entanglements. The information collected and lessons learned help increase responder safety and reduce or mitigate harm from future entanglements. From 2007 through 2020, the Network documented 1,007 large whale entanglements involving ten species. Humpback whales (*Megaptera novaeangliae*) were the most frequently entangled large whale, accounting for 69% of all entanglements, followed by gray whales (*Eschrichtius robustus*), minke whales (*Balaenoptera acutorostrata*), and North Atlantic right whales. Analyses of the most recent entanglement data (2017 through 2020) show that the vast majority of these entanglements involved fishing gear, with 51% of all entanglements attributed to specific fisheries. When feasible, Network members respond to all reported life-threatening cases. Successful responses assess the entanglement and its impact, and if prudent and possible, authorized responders remove entangling material. Since 2017, the Network has mounted responses to 31% of all reported live entangled large whales, resulting in the partial or full disentanglement of 25% of confirmed cases. While these efforts improved the chances of survival for many whales, preventing entanglements is the ultimate solution to this problem.

Filling a Gap in West Coast Marine Acoustic Data: An Interdisciplinary Effort.
Adelle Wilkin1, Madeline Schroth-Glanz2
1California Polytechnic State University San Luis Obispo, San Luis Obispo, California, 2California Polytechnic University, San Luis Obispo, CA

Understanding and maintaining ocean ecosystems is a crucial yet difficult task, which is made easier with the use of bioacoustics. Unfortunately, there are vast areas of the marine soundscape along the Central Coast of California which are understudied due to a lack of active hydrophone deployments. Our aim is to develop efficient and cost effective methods of acoustic data collection and analysis with collaborative efforts from Engineering, Data Science, and Marine Science students. Our goal is to (1) help contribute to the collection efforts of marine acoustic data along the Central Coast of California with a local deployment and (2) streamline data analysis through automatic detection models. Cal Poly Engineers are developing and testing technology to ensure effective deployment, mooring design, and retrieval of hydrophone data in San Luis Obispo County. Meanwhile, training data of acoustic recordings from a week-long deployment in Monterey Bay, annotated by our Marine Science students, is being utilized by our Data Science team to create an automatic detection model for common marine mammal species. This analysis provides insight into the format of the data collected and the species we may encounter in local waters. In order to accurately extract important signals from these kinds of data, manual annotation is required. However, processing the audio files in this manner is tedious and can take almost 3-4x the duration of the audio, thus requiring better methods of detection.

With these tools, we will compare data from our deployment in San Luis Obispo to data collected from Monterey Bay, evaluating the differences in soundscape and marine mammal presence between the two locations along the California
coastline. Moving forward, this data may allow for more targeted research and conservation efforts on species commonly found along the central coast.

**Estimating Changes in Humpback Whales (Megaptera Novaeangliae) Migrations Past Cape Vidal, South Africa**

Chris Wilkinson¹, Ken Findlay², Elisa Seyboth³, Jennifer Olbers⁴

¹Mammal Research Institute, Pretoria, South Africa, ²Centre of Sustainable Oceans Economy, Cape Peninsula University of Technology, Cape Town, South Africa, ³Cape Peninsula University of Technology, South Africa, ⁴Wildlands Trust, South Africa

Southern Hemisphere humpback whales, *Megaptera novaeangliae*, generally migrate annually from summer Antarctic feeding grounds to winter breeding grounds in coastal tropical waters, including off Southern Africa. Given changing ocean conditions and partial population recovery from whaling, there may be possible changes in the seasonal abundance and migration characteristics of migrating whales over the last decades. Shore-based surveys were performed from two 70 m-high independent platforms located 22 m apart from each other at Cape Vidal, KwaZulu-Natal, South Africa, in 2018 and 2019 to allow a comparison with data collected in the same area in 1988, 1991, and 2002. This research also aims to estimate the relative population size and trends of humpback whales in the region. Whale groups were tracked daily by position-fixing on surfacing bouts using survey theodolites. Numbers of whales observed or projected to cross the midline of the survey area within the observation period each day were tallied in each of three distance bins (near, mid, and distant). Mark-recapture based assessments of missed groups between platforms were estimated and counts were adjusted to account for daily sighting effort and missed proportions by distance offshore and sighting condition.

Adjusted daily sighting tallies were aggregated across each season. A total of 10 498 (2018) and 11 009 (2019) individuals were estimated in the migrations. An annual increase rate of between 7-8% has been estimated over 31 years from 1988. This represents a slight decrease of the previous 1988-2002 rate of 11.0% possibly indicative of the population approaching ecological carrying capacity.

**Food Fight? Assessing the Trophic Overlap of Resident Common Bottlenose Dolphins (Tursiops truncatus) and Coastal Shark Species off Sarasota, Florida**

Krystan A. Wilkinson¹, Randall Wells², Robert E. Hueter³, John Morris⁴, Lisa Hoopes⁵, Judith Bakker⁶, Maurits P.M. van Zinnicq Bergmann⁷, Sam Rossmann⁸, Theresa-Anne Tatot-Naecker⁹, Valerie Hagan⁴

¹Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, FL, ²Chicago Zoological Society's Sarasota Dolphin Research Program, Sarasota, Florida, ³Center for Shark Research, Mote Marine Laboratory, Sarasota, FL, ⁴Sharks and Rays Conservation Research Program, Mote Marine Laboratory, Sarasota, FL, ⁵Georgia, ⁶Florida International University, North Miami, Florida, ⁷Hubbs SeaWorld Research Institute, ⁸University of California Santa Cruz, Santa Cruz, CA

The identification of shared prey resources among top predators can help disentangle complex trophic interactions which may have profound implications for ecosystem structure and function. Sharks and dolphins play critical roles in coastal marine environments as top predators. Sarasota Bay, Florida, is home to a long-term resident community of common bottlenose dolphins (*Tursiops truncatus*) in addition to various shark species. Bull sharks (*Carcharhinus leucas*) and tiger sharks (*Galeocerdo cuvier*) are thought to be the most frequent predators of Sarasota Bay dolphin residents. However, shark-dolphin dietary
overlap and the potential for sharks to engage in intraguild predation with dolphins have thus remained unexplored in Florida Gulf waters. Here, we used stable isotope, fatty acid and DNA metabarcoding analyses to investigate the trophic position, as well as the isotopic and dietary niche overlaps, between bull, tiger, sandbar (C. plumbeus) and blacktip (C. limbatus) sharks and compared them to information available for the Sarasota Bay dolphin community. Blood samples were collected from 37 blacktip sharks, 14 bull sharks, 53 sandbar sharks, and one tiger shark. Cloacal swabs were collected from 37 blacktip sharks, 18 bull sharks, 83 sandbar sharks, and two tiger sharks. DNA metabarcoding results identified mullet (Mugil cephalus), pinfish (Lagodon rhomboides), Atlantic thread herring (Opisthonema oglinum), and scaled herring (Harengula jaguana) – among others – in the diets of the coastal shark species. These prey species are also relatively frequent diet components of the local dolphin community. Overlap in prey could indicate that dietary competition between sharks and dolphins is higher than expected in this area. This may have serious consequences when prey resources are scarce, such as during harmful algal blooms.

**Extreme Physiological Responses in a Deep-Diver Designed to Marathon, the Narwhal (Monodon monoceros)**

*Terrie Williams*¹, Mads Peter Heide-Jørgensen²

¹University of California Santa Cruz, Santa Cruz, California, ²Greenland Ins. of Natural Resources, Copenhagen K, Denmark

The increased presence of humans in Arctic waters afforded by deterioration of polar sea ice has resulted in new, pervasive threats to local marine mammals. One of the most vulnerable species to these activities is the narwhal, one of two year-round Arctic resident odontocetes. As a deep-diving cetacean that routinely forages at 500 - 700 meter depths, narwhals maintain comparatively large oxygen stores including high concentrations of myoglobin (7.87 +/- 1.72 g/100 g wet muscle) and a high proportion (>80%) of slow twitch oxidative fibers in locomotory muscles. The profile is one of an endurance athlete designed for marathon type performance. To determine how such an athletic profile defines the capacity of narwhals to respond rapidly to unanticipated disturbance, we developed an Endurance Performance Scale (EPS) that compares different diving and swimming efforts. Based on the proportion of the calculated aerobic dive limit utilized, inter-dive recovery metrics including EPOC (Exercise Post-Exercise Oxygen Consumption), and sequential dive behaviors, the EPS standardizes comparisons between resting, foraging, and traveling periods, and escape performances associated with human activities and seismic noise. We used data from nine adult/sub-adult narwhals (body mass range = 725 - 1500 kg) from Scoresby Sound, East Greenland that were outfitted with custom electrocardiographic-accelerometer-depth recorders. Each tag continuously monitored heart rate, acceleration and stroking movements, depth, and inter-dive respiration frequency. EPS rankings indicated that narwhals defended aerobic dive limits regardless of dive duration or depth per se with the percentage oxygen store used = 57.0 +/- 5.4 SEM for control (n = 10 events) and 110.3 +/- 8.4 SEM for escape periods (n = 8). A major differentiating factor affecting total energetic costs and recovery was the duration of gliding during descent. Together, these performance metrics demonstrate specific physiological design limits for an endurance diver that may hinder escape from novel threats.

**A New Transmitted Data Product to Infer Dive Behavior: Empirical Cumulative Distributions of Time-At-Depth**

*Kenady Wilson*¹, Josh London², Matthew Rutishauser³, Carey Kuhn¹, Daniel Costa⁴, Patrick Robinson⁵

¹Wildlife Computers, Bend, OR, ²Alaska Fisheries Science Center's Marine Mammal Laboratory /
Transmitting dive data from animal-borne biologgers enables the collection of behavior data from free-ranging animals; however, the amount and type of data received can vary greatly based on the design, configuration, and data encoding (the data product). Histograms were some of the first data products created and provide information about time spent in pre-determined bins over a summary period (e.g. 6 hr). Empirical Cumulative Distributions of time-at-depth (ECD) are a refinement of histograms where bins are not pre-defined. This accommodates both individual variability and/or dive behavior that is not well understood. Metrics for individual dives can be transmitted; but a limited number of dives can fit into a single Argos message (e.g. 5 dives for Wildlife Computers’ Behavior Log). For all data products, increasing the number of messages also increases the potential for data gaps if the required throughput exceeds the capabilities of the satellite system. Using standard programming setups for three pinniped species (harbor seal, northern fur seal, and northern elephant seal) we simulated and compared the outputs for Behavior Log and ECD on Wildlife Computers tags. The simulations were run using varying ECD summary periods (1-24 hr) and varying probabilities of reception (0.01 - 0.5), representative of the Argos satellite system. The number of messages generated and the percent coverage per day were used as metrics to compare the output from 2,175 simulations. For all three species, ECD generally provided more continuous data. A 1-hr summary period generates 12 ECD messages/day. For Behavior Log, 120 dives/day generates 24 messages/day, and 50 dives generates 10 messages. This suggests that ECDs will be better suited than Behavior Log when continuous data is needed and behavior summaries are sufficient. Understanding the impact of species behavior on data products will help researchers identify the programming parameters that best suit their study objectives.

Spatial and temporal variation in harbour seal diving behaviour
Nicole Wilson1, Gordon Hastie2, Katherine Whyte3
1University of St Andrews, St Andrews, Fife, United Kingdom, 2Sea Mammal Research Unit, St Andrews, 3University of St Andrews, United Kingdom

Despite being one of the most commonly studied marine mammal species, there is a relative paucity of information on the temporal and spatial determinants of diving behaviour in harbour seals (Phoca vitulina). To address this, 18 harbour seals were fitted with GPS/GSM telemetry tags (SMRU Instrumentation, University of St Andrews) in The Wash, southeast England, UK during 2016. The available seal tag data spans from October to June providing nine months of continuous diving behaviour. Dive depth and movement data obtained from tags was utilized to (1) quantify individual-level dive metrics: dive depth, duration, and proportion of the water column used, (2) compare dive metrics across individuals spatially, and to measure patterns across diel, tidal, and seasonal cycles, and (3) use these parameters to investigate how these dive behaviours overlap with renewable energy development in the area. Environmental data obtained from open-source repositories (i.e., European Marine Observation and Data Network, Cefasdata hub, and the National Oceanography Centre (NOC) POLPRED offshore tidal software) was used to compliment location and depth data to provide additional abiotic context to the dives. A number of different regression approaches were used to assess the relationship between each dive metric...
and several temporal and spatial variables, accounting for repeated measures amongst individuals where necessary. Preliminary data exploration and modelling suggests that both spatial and temporal patterns are present, but with variability between individuals. Additionally, substantial changes in the durations and depths of dives have been observed when seals were in close proximity to offshore wind farm developments. The results of this study will improve our knowledge of harbour seal diving activity and allow for a more accurate assessment of animal responses to man-made stressors, especially with regards to management efforts involving offshore industrial developments, which continue to increase in abundance.

Conditions Associated with Grey Seal (Halichoerus grypus) Pup Production Variation in the UK
Megan Withers¹, Lars Boehme²
¹University of St Andrews, Atlanta, GA, ²University of Andrews, St Andrews, United Kingdom

The grey seal (Halichoerus grypus) is an influential top predator in the marine ecosystem and has benefitted from long-term protection and monitoring in the United Kingdom (UK). Population trends have been well defined for the species with population growth having plateaued in most regions around the UK. However, deviation in pup production from long-term birth models remains unexplained. Recent research indicates that food quality and availability may affect grey seal reproductive success. This study investigates whether variation in pup production can be explained by environmental and/or biogeochemical variables known to both directly and indirectly influence prey species of grey seals. This was achieved with the use of aerial population survey data collected by the Sea Mammal Research Unit (SMRU) and open-source repositories for environmental and biogeochemical data. Survey regions include the Inner Hebrides, Outer Hebrides, Orkney, and the North Sea. Variables include sea surface temperature, sea-floor temperature, and chlorophyll-α. These variables were selected due to their influence on an inter-trophic relationship between phytoplankton, copepods (Copepoda), and the lesser sandeel (Ammodytes tobianus), which can influence grey seal foraging success. The relationship between pup production and the North Atlantic Oscillation (NAO) was also assessed due to the NAO’s known impact on reproductive timing. The data were partitioned according to survey region and their correlation with regions’ pup production model residuals assessed using generalized linear models (GLMs) and correlation tests. Preliminary results suggest correlation between environmental variables and pup production residuals. Defining influences on grey seal reproductive success will advance current understanding of the species and its population dynamics, thereby supporting effective management of grey seals in a changing environment.

Aldosterone detection in skin biopsies of lactating gray whales
Christiana Wittmaack¹, Jorge Urban², Daniela Bernot Simon³, Sergio Martínez Aguilar³, Jon'Ayo Farquharson¹, Erangi Heenkenda³, James DeWoody⁴, Seenivasan Subbiah⁵, Celine Godard-Codd⁷
¹Texas Tech University, ²Universidad Autonoma de Baja California Sur, La Paz, BCS, Mexico, ³Universidad Autonoma de Baja California Sur, Programa de Investigacion de Mamiferos Marinos, Mexico, City, ⁴Purdue University, ⁵The Institute of Environmental and Human Health, Texas Tech University, Lubbock, Texas, ⁶Texas Tech University /The Institute of Environmental and Human Health, Lubbock, Texas

Aldosterone, a mineralocorticoid, has been reported as an indicator of stress in cetaceans, likely due to its role in sodium conservation. One area that has yet to be explored in cetacean
research is whether aldosterone is associated with lactation. Aldosterone has evidenced to be an important hormone in lactating terrestrial mammals. Biopsies were obtained from 24 gray whale (Eschrichtius robustus) cows and calves from the San Ignacio Lagoon, Baja California, Mexico. Hormone extraction was performed using liquid-liquid extraction. Analysis of 10 reproductive and stress steroid hormones (androstenedione, aldosterone, cortisol, cortisone, corticosterone, 17β-estradiol, estrone, 17α-hydroxyprogesterone, progesterone, and testosterone) was performed using liquid chromatography mass spectrometry. All methodology had been optimized and validated for 50mg of blubber during a prior study. When skin tissue was available, animal sex was confirmed via genetic analysis. The predominant hormone expressed in lactating cows was aldosterone. Mean concentrations were significantly higher compared to all other hormones detected in lactating cows (p<0.001). Out of the 10 steroid hormones on the panel, 9 were detected in lactating cows and calves (aldosterone, cortisol, cortisone, corticosterone, 17β-estradiol, estrone, 17α-hydroxyprogesterone, progesterone and testosterone). The highest aldosterone concentrations were observed in a lactating cow at 20.0ng/g. The highest concentrations of all other hormones observed in both cows and calves were 7.5ng/g (cortisol, calf), 7.8ng/g (cortisone, cow), 24.6ng/g (corticosterone, calf), 16.5ng/g (17β-estradiol, calf), 11.9ng/g (estrone, cow), 33.7ng/g (17α-hydroxyprogesterone, calf) 3.4ng/g (progesterone, cow), and 2.9ng/g (testosterone, calf).

Phylogenomic and demographic analyses of Australian Tursiops reveal a potential offshore origin of the proposed novel species T. ‘australis’
Samuel Wittwer¹, Simon Allen², Livia Gerber³, Michael Krützen⁴
¹University of Zurich, Zürich, Zürich, Switzerland, ²University of Bristol, Bristol, Bristol, United Kingdom, ³University of Zurich, Switzerland, ⁴University of Zurich, Zurich, Switzerland

Both currently recognized species of bottlenose dolphins (genus Tursiops) are found around Australia, with T. truncatus occurring predominantly in deeper, offshore regions and T. aduncus in more strongly structured populations in shallow, coastal waters. The Burrurun dolphin, T. ‘australis’, occupying a similar habitat to T. aduncus in coastal waters of Victoria, Tasmania, and potentially South Australia, was described based on genetic and morphometric evidence but has not been formally recognized. Subsequent studies found conflicting signals between autosomal and sex-linked markers and identified two clusters which, although they both carry the ‘australis’ mtDNA haplotype, autosomally cluster with T. aduncus in South Australia and with T. truncatus in Victoria/Tasmania. We performed phylogenetic and demographic analyses using mitochondrial genomes (n = 40) and genomic sequences produced using a ddRAD approach (n = 161, 2.2 Mbp, 35,721 SNPs). Our ddRAD-based phylogenomic tree contradicts a published topology and identifies Victorian and Tasmanian T. ‘australis’ as a sister group to T. truncatus, rather than T. aduncus. Results from demographic models based on a diffusion approximation approach show that the Victorian/Tasmanian T. ‘australis’ cluster was likely founded by a small fraction of individuals originating from T. truncatus, roughly 100kya. The best-scoring models inferred ongoing unidirectional or asymmetric gene flow higher from T. truncatus into T. ‘australis’, suggesting that the T. ‘australis’ population may continue to receive migrants from offshore populations. Our mtDNA phylogenetic analyses confirm the T. ‘australis’ mtDNA haplotype as basal to all Tursiops. Additionally, we identified two subclades within the ‘australis’ mtDNA clade which consistently separate South Australian
from Victorian/Tasmanian samples. These results are consistent with the previously identified conflicting clusters carrying the ‘australis’ mtDNA haplotypes and point to an independently evolving South Australian mtDNA lineage which may be the result of introgression from *T. australis* into South Australian *T. aduncus*.

Deep Learning-Based Recognition of Individual Bottlenose Dolphin Signature Whistles

Piper Wolters¹, Frants Havmand Jensen², Laela Sayigh¹, Evan Morrison¹, Gracie Ermi¹, Scott Smith¹, Randall Wells⁶, Sam McKennoch⁷, Louisa Van Zeeland⁷

¹Allen Institute for Artificial Intelligence, Bellingham, Washington, ²Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, ³Woods Hole Oceanographic Institution/Hampshire College, Woods Hole, Massachusetts, ⁴Woods Hole Oceanographic Institution, ⁵Allen Institute for Artificial Intelligence, ⁶Chicago Zoological Society’s Sarasota Dolphin Research Program, Sarasota, Florida

Bottlenose dolphins produce individually distinctive signature whistles that are used to recognize familiar conspecifics both to maintain group cohesion and to mediate group encounters at sea. Signature whistles have a highly stereotyped frequency-modulated pattern that can be repeated a variable number of times, with or without silent intervals between renditions. Typically, signature whistles are classified manually by visually inspecting spectrograms, but such an approach is time-consuming and prevents scaling up for acoustic monitoring. Here we test how widely available off-the-shelf convolutional neural network (CNN)-based classifiers can detect and recognize different signature whistles. We use a newly constructed database of signature whistles from known individuals in Sarasota, FL, obtained using suction-cup hydrophones placed on the melon of dolphins while briefly restrained during health assessments. We tested classification accuracy with MobileNetV2 to evaluate the potential of automating the dolphin whistle identification process. For 70 individuals with 200 samples each, we achieve initial results of 97.3% validation accuracy, increasing to 97.7% validation accuracy when pitch or speed augmentation were added to 20% of training data.

These results demonstrate that CNN-based classifiers can differentiate between individual bottlenose dolphin signature whistles with a high degree of accuracy. Our findings also demonstrate the potential of augmentation in circumstances where labeled data are difficult or expensive to obtain and where whistle recordings contain more variation and background noise (once the models are applied outside of this specific dataset). These automatic classification techniques allow for monitoring movements and habitat use of individual bottlenose dolphins acoustically through their individually distinctive signature whistles. Furthermore, if a large enough sample of the population is known, automated detection of individual dolphins can be combined with mark-recapture analyses to estimate population size and ultimately to monitor how populations change as a function of increasing coastal development or other anthropogenic impacts.

Seals as Ice Sentinels in Tidewater Glacier Fjords

Jamie N Womble¹, Perry Williams², Robert McNabb¹, Linnea Pearson⁴, Anupma Prakash¹, Rudiger Gens⁶, Benjamin Sedinger⁷, Cheyenne Acevedo⁷

¹National Park Service-Glacier Bay Field Station, Juneau, Alaska USA, Auke Bay, Alaska, ²University of Nevada Reno, ³Ulster University, Coleraine, United Kingdom, ⁴California Polytechnic State University, ⁵University of Alaska Fairbanks, Fairbanks, Alaska, ⁶Alaska
Satellite Facility, Geophysical Institute, University of Alaska Fairbanks, Fairbanks, Alaska, University of Nevada Reno, Reno, Nevada

Tidewater glaciers calve icebergs into the ocean which serve as pupping and molting habitat for some of the largest seasonal aggregations of harbor seals (*Phoca vitulina richardii*) in the world. Although they are naturally dynamic, advancing and retreating in response to local climatic and fjord conditions, most tidewater glaciers around the world are thinning and retreating. Climate change models predict continued loss of ice with unknown impacts to organisms that rely on ice as habitat for critical life history events. To understand the impacts of changing ice availability on harbor seals, we quantified annual and seasonal changes in ice in Johns Hopkins Inlet, a tidewater glacier fjord in Glacier Bay National Park, Alaska. Systematic aerial photographic surveys (*n* = 91) of seals and ice were conducted during the pupping (June; *n* = 47) and molting (August; *n* = 44) seasons (2007-2019). Object-based image analysis was used to quantify the availability and distribution of ice. Multivariate spatial models were developed for jointly modeling stage-structured seal location data and ice. There was substantial interannual and seasonal variation in the amount and distribution of ice, with 2011 and 2012 standing out as particularly icy years. Ice habitat was dramatically reduced in 2018 and 2019, resulting in decreased seal abundance. On average there was 7.8 times more ice during June than August, which was likely driven by seasonal variation in physical processes that influence the calving dynamics of tidewater glaciers. Nonpup seals and ice were correlated during the pupping season (*λ*$_{1,3}$ = 0.27; 0.23 - 0.31), but this correlation was reduced during the molting season (*λ*$_{1,3}$ = 0.22; 0.17 - 0.27) suggesting that seals may respond to changes in habitat differently depending upon trade-offs associated with life history events, such as pupping and molting, and energetic costs and constraints associated with the events.

**Measuring Acoustic Activity and Skin Cortisol as a Method to Evaluate Welfare in Captive Beluga Whales (Delphinapterus Leucas)**

Chung Hei Wong¹, Jiann-Hsiung Wang¹, Yi-Jing Xue¹, Ming-An Tsai¹, I-Chun Chen¹, Jack Wei-Cheng Yang²

¹Conservation Medicine Lab, Dept. Vet Med, NTU, Taiwan, Taiwan, ²Conservation Medicine Lab, Dept. Vet Med, NTU, Taipei, Taiwan

With the broadening of focus from animals on farms to zoos and aquaria, the field of welfare science and public concern for animal welfare grow nowadays. In captive animals, stress and its causes are topic of interest in welfare issues. Previous studies have showed that intrinsic and extrinsic stressors can cause psychological and physiological impacts to many mammals. Because stress could reflect the adverse effect in an animal’s welfare, an objective method to assess animals’ stress will be essential. Using both behavioral and physiological parameters as indicators to assess animal welfare quantitatively, rather than simply qualitatively, should be more valid indicator of animal welfare than behavioral measures alone and will prevent the occurrence of the bias cause by attribution. To validate this approach, acoustic activity and skin cortisol concentration have used to evaluate the animal welfare in captive beluga whales (*Delphinapterus leucas*) in Taiwan. The acoustic activity (5 min per hour) of three captive beluga whales has been recorded by transducer routinely, and are analyzed using audio editing software (Kaleidoscope, Wildlife Acoustics). The scrape skin samples have been collected non-invasively twice every week from all three animals. All animals had received pre-sampling training in order to collect scrape samples without or reducing potential stress. Cortisol was extracted using a modified skin steroid extraction technique delineated in previous study, and
detected via commercially available enzyme immunoassays. The changes of acoustic activity and cortisol levels during specific events provided evidence that these two measurements could be applied for evaluating animal welfare in captive beluga whales. Using these two non-or less-invasive method simultaneously may contribute to identify and mitigate extrinsic stressors and improve management and husbandry for maintain the welfare in captive cetaceans.

Effectiveness of a 50-yard no-approach rule and a no-swim-with rule for protecting spinner dolphins in Hawaiʻi from human interactions: an initial assessment

Kimberly Wood¹, Katie Abrams², Robin Baird³, Paige Nankey²
¹University of Hawaii, Honolulu, HI, ²Colorado State University, Fort Collins, Colorado, ³Cascadia Research Collective, Olympia, WA

Spinner dolphins (Stenella longirostris) in Hawaiʻi rest during the day in nearshore bays where they are the focus of considerable attention from humans. This includes individuals who swim to and attempt to interact with dolphins (either from shore, kayaks, or standup paddleboards (SUPs)), as well as recreational and commercial kayaks and boat tours. Until October 2021, human-dolphin interactions were managed by the National Marine Fisheries Service (NMFS) through a regulation prohibiting “harassment” and voluntary guidelines. Given the difficulty of enforcing the harassment rule and the lack of compliance with guidelines, in October 2021, NMFS finalized a no-swim-with rule and a 50-yard (46 m) no-approach rule. In November and December 2021, we monitored spinner dolphin-human interactions from shore in part to assess compliance with the new regulations. Observations were made at three resting bays (Kealakekua, Hōnaunau, Kauhakō/Hoʻokena) along the west side of Hawaiʻi Island, using a drone (typically flown at >150’ elevation) and hand-held 10x binoculars. The number of swimmers, human-powered watercraft (e.g., kayaks/SUPs), and motorized watercraft within 50 yards of dolphins (i.e., violations), and between 50-100 yards of dolphins were recorded at 5-minute intervals. During 49 hours of dolphin-human observations over 15 days, on-water law enforcement presence was recorded within the bays on three days (two hours, ~4.1% of observation time), and on-land enforcement presence was recorded on three days. While the proportion of observation periods with violations was high (grand mean=51%), in general there were more swimmers/watercraft at 50-100 yards than <50 yards. Violations involving swimmers were recorded much more frequently than those involving kayaks/SUPs or motorized watercraft (36.1%, 14.2%, and 0.3% of observation periods, respectively). Overall, our results demonstrate that shortly after the new regulations went into effect enforcement presence was minimal and violations of the regulations regularly occurred off Hawaiʻi Island.

Debunking Misconceptions: Marine Mammals and Seabirds have Limited Impacts on Fisheries Catches in the North Sea

Matthew Woodstock¹, Jeremy Kiszka, James Waggitt², Peter Evans³, Yuying Zhang⁴
¹Florida International University, North miami, FLORIDA, ²Bangor University, Menai Bridge, Gwynedd, United Kingdom, ³Sea Watch Foundation, Amlwch, Gwynedd, United Kingdom, ⁴North miami, FLORIDA

Marine mammals and seabirds are relatively high trophic level consumers with high metabolic rates and have therefore the potential to significantly impact community dynamics. Since the early 2000s, the abundance several marine mammal species markedly increased in the southern North Sea and eastern English Channel while seabird abundance has remained relatively stable since the early 2000s. The fishing effort of
demersal gears has declined while pelagic gear effort has increased. To evaluate the top-down effects of marine mammals and seabirds, and their impact on fisheries, we have developed an ecosystem model for the southern North Sea and eastern English Channel. The model was simulated from 2003 to 2014, forcing changes of marine mammal abundances and fishing effort according to available data. Fisheries have a greater trophic impact on the ecosystem than marine mammals and seabirds (including commercial fish stocks) but can also provide greater bottom-up support for non-commercial species. The indirect trophic impacts that marine mammals exert on fisheries are not significant, a result likely corresponding to predation on non-commercial organisms. Initially, fisheries removed more biomass than the combined consumption of marine mammals and seabirds by a factor of 1.37, and this gap widened throughout the simulation. The effect of rising marine mammal and stable seabird populations on commercial fish stocks in the southern North Sea and eastern English Channel is substantial but limited relative to the impact of fisheries, and the changes to marine mammal populations are less influential towards ecosystem processes than fluctuations in fishing effort.

Social survival: humpback whales (Megaptera novaeangliae) use social structure to partition ecological niches within proposed critical habitat
Janie Wray¹, Eadin O'Mahony², Eric Keen³
¹North Coast Cetacean Society, Qualicum Beach, British Columbia, ²University of St Andrews, Cork, Ireland, ³Scripps Institution of Oceanography, La Jolla, California

Animal culture and social bonds are relevant to wildlife conservation because they influence patterns of geography, behavior, and strategies of survival. Numerous examples of socially-driven habitat partitioning and ecological-niche specialization can be found among vertebrates, including toothed whales. But such social-ecological dynamics, described here as ‘social niche partitioning’, are not known among baleen whales, whose societies -- particularly on foraging grounds -- are largely perceived as unstructured and incidental to matters of habitat use and conservation. However, through 16 years of behavioral observations and photo-identifications of humpback whales (Megaptera novaeangliae) feeding within a fjord system in the Canadian Pacific (primarily within Gitga’at First Nation waters), we have documented long-term pair bonds (up to 12 years) as well as a complex societal structure, which corresponds closely to persistent patterns in feeding strategy, long-term site fidelity (extended occupancy and annual rate of return up to 75%), specific geographic preferences within the fjord system, and other forms of habitat use. Randomization tests of network congruency and clustering algorithms were used to test for overlap in patterns of social structure and habitat use, which confirmed the occurrence of social niche partitioning on the feeding grounds of this baleen whale species. In addition, we document the extensive practice of group bubble net feeding in Pacific Canada. This coordinated feeding behavior was found to strongly mediate the social structure and habitat use within this humpback whale society. Additionally, during our 2004 – 2019 study, we observed a shift in social network structure in 2010 – 2012, which corresponded with environmental and demographic shifts including a sudden decline in the population’s calving rate. Our findings indicate that the social lives of humpback whales, and perhaps baleen whales generally, are more complex than previously supposed and should be a primary consideration in the assessment of potential impacts to
Historical distribution and migratory patterns of one of the world’s rarest whales, the North Pacific right whale, revealed by stable isotope analysis of century-old baleen

Dana Wright1, Geraldine Rosalie Busquets Vass2, Seth Newsome3, Andy Read4
1Duke University Marine Laboratory, Beaufort, NC, 2Centro de Investigación Científica y de Educación Superior de Ensenada, Unidad La Paz, La Paz, Baja California Sur, Mexico, 3University of New Mexico, Department of Biology, Albuquerque, 4Duke University, Beaufort, North Carolina

The North Pacific right whale (NPRW; Eubalaena japonica) is one of the world’s most endangered cetaceans. Two populations are recognized: the endangered western population, believed to number in the low hundreds of animals, and the critically endangered eastern population (n<35 animals). Important gaps exist in our basic knowledge of this species—overwintering areas, migratory routes, and locations of calving grounds—but the extreme rarity of these whales precludes traditional approaches to acquiring this knowledge. To investigate seasonal movement patterns of historical NPRWs, we analyzed stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values of baleen from three whales (one eastern population, one western population, and one of unknown origin) harvested from 1862-1961. We sampled baleen tissue every 2 cm from the proximal end to the distal tip, allowing for a multi-year reconstruction of each whale’s ecological history. To compare resource use among individuals, we calculated the Bayesian standard ellipse area (SEA) for each plate. Trends in the time-series of both $\delta^{13}C$ and $\delta^{15}N$ values revealed oscillations suggesting annual movement for the eastern and western animals, with longer and more variable annual growth rates estimated for the eastern (28 ± 3.6 cm yr$^{-1}$) than the western (18 ± 1.4 cm yr$^{-1}$) samples. In contrast, the ‘unknown population’ animal does not have the characteristic sinusoidal longitudinal pattern. The SEA of the eastern animal was 2.4 times larger than the western animal (mode 3.1‰ and 1.3‰, respectively) and overlapped partially with the western and unknown population animal only during presumed summer feeding periods. These data suggest that the two populations occupy isotopically distinct areas during winter and that individuals of both populations undergo annual migrations. We plan to analyze a subset of these data for amino acid $\delta^{13}C$ and $\delta^{15}N$ values to partition the observed isotopic variation in bulk tissues to movement, diet, or physiology.

Growth-related changes in speckles of wild Indo-Pacific bottlenose dolphin (Tursiops aduncus)

Genfu Yagi1, Mai Sakai2, Kazunobu Kogi3
1Mie University, Kanagawa, Japan, 2Kindai University, Nara, Japan, 3Mikura Island Tourist Information, Mikura Island, Tokyo Prefecture, Japan

Mammals that change their body color throughout their lives are rare. In cetaceans, there are some species that exhibit this character. In the Indo-Pacific bottlenose dolphin (Tursiops aduncus), speckles appear with growth. There exists only one study that has examined the relationship between age and speckle appearance in this species in Australia. We examined the speckle state with aging for this species ranging around Mikura island in Japan. Here we described the relationship between real age and speckle appearing. This study aims to contribute to clarify the function of coloration and to estimate the age based on speckles. We analyzed underwater video data recorded between the years 2003 and 2019 and focused on 107 identified dolphins. The speckles first appeared on the ventral part of the genital area at an average age of 6.5 years. Speckles increased in two specific directions: from the genital area to the jaw and from the ventral to the lateral side. The speckles were dotted when they first
appeared but the dots merged with age. The relationship between age and speckle appearance was found to be similar in most individuals. Speckles were most likely to appear throughout their life; accordingly, they may function as visual signals of age. We discovered no speckles around the genital slit and this area was larger in females than in males. Because the age of the first speckle appearance was close to the age of the first birth in females, it may also help in the identification of sexual maturation. We also succeeded in creating an age estimation method using a general linear model based on speckle density in four body parts.


Shelby Yahn1, Robin Baird2, Sabre Mahaffy3

1Cascadia Research Collective, 2Cascadia Research Collective, Olympia, WA, 3Cascadia Research Collective, Olympia, Washington

Identifying an individual’s sex improves the ability to make population and life history assessments, though current methods of identifying sex from most delphinids at sea are limited. Free-ranging individuals of four species (short-finned pilot, pygmy killer, melon-headed, and false killer whales) thought to be sexually mature were sexed using PCR molecular analysis (n=179) or recurring calf association (n=142), then profiled from photos to assess proportional fin and body measurements. Pygmy killer whales showed no evidence of sexual dimorphism in fin or body proportions, but sexually dimorphic characteristics were identified for the three other species, in all cases with males having larger dorsal fins proportional to anterior body length (pilot and false killer whales P<0.001, melon-headed whales P=0.007). This was the only significant dimorphism for false killer whales, but melon-headed whales had two additional measurements indicating males have wider dorsal fin tips, though not strongly evident or significant (P=0.035, P=0.099). Pilot whales had the most sexually dimorphic traits, with 11 of 14 proportions significantly different between sexes. This confirms qualitative observations of male short-finned pilot whales having proportionally larger dorsal fins with a more pronounced leading edge. All sexually dimorphic traits across pilot, melon-headed, and false killer whales showed the same trends in sexual bias, indicating similar functionality of dimorphism. Results indicate that adult short-finned pilot whales are strongly sexually dimorphic, could be accurately sexed in the field or lab, and their dimorphic features can reliably denote male sexual maturity. Adult melon-headed and false killer whales have subtle but present sexual dimorphism that can be detected using morphometric analysis of photos taken at sea, but these traits are insufficient to identify sexually mature individuals. For false killer whales, physical maturity may not be reached for 15-20 years after sexual maturity, and future analyses will investigate sexual dimorphism in physically mature males.

Health assessment information from live cetaceans stranded in Peru: A 20 year data set.
Carlos Francisco Yaipen-LLanos, Organization for Research and Conservation of Aquatic Animals - ORCA PERU, Surco, Lima, Lima, Peru

There is little information on health data from live stranded cetaceans specially in the South Pacific where these elusive species could get stranded in inaccessible, isolated and distant locations. However, the development of a civilian Stranding Network lead by ORCA in Peru had provided access to live cetaceans for health assessment, rescue and rehabilitation during 20 years. The aim of this work is to present an organized data set on medical findings...
from cetacean stranded alive along the Peruvian coast. In a transversal clinical analysis of data for each case, different planes of medical findings were documented from live Megaptera novaeangliae, Balaenoptera musculus, Physeter macrocephalus, Eubalaena australis, Ziphius cavirostris, Globicephala macrorhynchus, Peponocephala electra, Kogia breviceps, Delphinus delphis, Lagenorhynchus obscurus, Tursiops truncatus, and Phocoena spinipinnis. Medical findings included physical examination, measurement of vital signs, clinical signology, hematology, kidney profile test, liver profile test, methylmercury detection, immunoglobulins tests, estrogen level test, and post-mortem tissue biopsies from terminal cases. Health assessment findings were classified as skin syndrome, digestive syndrome, metabolic syndrome, immune suppression syndrome, intoxication syndrome, and degenerative syndromes. Out of the total of cetaceans recorded, only 8.7% (N=540) of cases were alive. Survival rate of live cetaceans documented reached 31.9% (n=47) overall with reinsertion or release after rehab. The importance of this material comes from the need to create background for medical findings expanding the knowledge on the health of cetaceans in the wild, their physiological response to diseases, and medical considerations applicable to distant location with limited technological access like Peru, setting stepping stones for a future generation of health assessment researchers, conservationist and stakeholders concern for cetacean lives. This is a useful classification of the only long-term cetacean live stranding medical record in Peru.

Dugongs (Dugong dugon) feed almost exclusively on seagrass. They leave “feeding trails”, which are unvegetated winding tracks, after feeding. The area, distribution and direction of the feeding trails have been used as indicators of their feeding ground utilization. However, current ground-based measurements of these trails require a large amount of time and effort. We have developed effective methods to observe the dugongs’ feeding trails using unmanned aerial vehicle (UAV) images. The method consists of three steps; (1) extracting the feeding trails from the images; (2) extracting the daily new feeding trails from the difference between two consecutive images and (3) estimating the directions of the feeding trails. We obtained aerial photographs from the intertidal seagrass bed at Talibong Island, Thailand from September 12 to 27th, 2019. The aerial photographs were geometrically corrected and were split into blocks of 256×256 pixels with ground sampling resolutions of around 0.5 cm/pixel. A pre-trained model using deep neural network (U-net) was trained on 46,565 images for the feeding trails extraction. It was also trained on 18,000 differential images for the extraction of daily new feeding trails. F1 scores, which are harmonic means of accuracies and precisions, for the feeding trails extraction were 89.5% and 87.7% for the images with ground sampling resolutions of 1 cm/pixel and 0.5 cm/pixel, respectively. The errors occurred when extracting old and ambiguous feeding trails. The F1 score for the extraction of the daily new feeding trails was 61.9%. The pixels extracted incorrectly as the daily new feeding trails were manually removed after the extraction. Direction distribution of the feeding trails was separated into two different clusters within the observation area (Kuiper test, p<0.005). These proposed methods will reduce the time and efforts required for feeding trails observations and contribute to assessments of the dugongs’ feeding ground utilization.
Computed tomography anatomy of the abdomen of the Indo-Pacific finless porpoises (Neophocaena phocaenoides)
Wei Yeng Yeong¹, Brian Chin Wing Kot², Heysen Hei Nam Ho³, Shuk Yee Kwan⁴, Gabrielle Yick Hey Ho⁵, Tabris Yik To Chung⁶, Henry Chun Lok Tsui⁷
¹City University of Hong Kong, Kowloon, Malaysia, ²City University of Hong Kong, Hong Kong, China, ³City University of Hong Kong & Royal Veterinary College, Tseung Kwan O, Hong Kong, ⁴City University of Hong Kong, ⁵City University of Hong Kong, Hong Kong, ⁶City University of Hong Kong S.A.R., China

Computed tomography (CT) is a non-invasive diagnostic imaging modality that has been increasingly applied in marine mammal medicine and research, as it provides high-quality and digitally storable data for assessing the anatomy, morphology, and pathology of marine mammals. Aside from clinical purposes, CT is applied in postmortem investigations as part of the virtopsy technique to enhance outcomes of conventional necropsy procedures. To maximise the efficiency of CT, it is essential to establish proper imaging anatomy references for one to be able to distinguish pathology from normal morphology.

In cetaceans, cross-sectional imaging anatomy studies with both CT and magnetic resonance imaging (MRI) have been conducted with the head. On the contrary, there are no published studies addressing the normal cross-sectional imaging anatomy of the cetacean abdomen, although it is an important area with multiple possibilities of pathology and injury. This study aimed to establish a reference for the normal CT cross-sectional anatomy of the cetacean abdomen. PMCT scans of two freshly dead (Code 2) Indo-Pacific finless porpoises, one male and one female, were performed in Hong Kong. Additional contrast study was performed with the female subject for comparisons with the non-contrasted PMCT scans. Using different image rendering techniques, most osseous and soft tissue structures were successfully depicted, including the male and female reproductive systems in the caudal abdominal region. Axial CT images were obtained at the medial plane of selected vertebral levels with optimised soft tissue windows (Subject 1: WW=560 & WL=200; Subject 2: WW=350 & WL=120). All selected transverse images were supplemented with corresponding hand-sketched labelled anatomical diagrams. This was the first study presenting a comprehensive documentation of cross-sectional PMCT imaging of the cetacean abdomen, which provided reference for CT clinical diagnosis and facilitated the integration of PMCT into postmortem investigation on diseases and anthropogenic impacts of these vulnerable species.

Marine Mammal Standard Methods: Streamlining NMFS Permit Applications for Common Research Procedures
Sara Young¹, Amy Hapeman², Shasta McClanahan³, Carrie Hubard⁴, Jordan Rutland⁵, Elise Kohli², Amy Sloan⁶
¹NOAA, Leesburg, VA, ²NOAA, ³NOAA, Silver Spring, MD, ⁴NOAA Fisheries, ⁵Georgia Sea Grant / NOAA Fisheries Office of Protected Resources, Silver Spring, Maryland, ⁶NOAA Fisheries Office of Protected Resources, Silver Spring, MD

The National Marine Fisheries Service (NMFS) Permits and Conservation Division is developing standardized methods for procedures commonly used in marine mammal research permit applications requested under the Marine Mammal Protection Act and Endangered Species Act. These pre-approved methods are designed to streamline the permit process by reducing the time it takes to complete an application, reducing potential questions on protocols, and simplifying application reviews. A standard method is a routine research method that is not likely to substantially change, other than minor improvements based on the best available
The mechanism for sealing the respiratory tract from water is not well understood. Recent observations have shown water entering the nasal passageways of whales and brought to question the protective role of the blowhole. Drone technology offers insights into this through an aerial perspective. In this research, we document instances of seawater entering the open nares during surfacing, and explore whether that water is extruded when the whale dives. This work has important implications for several areas of study. This includes behavior during high seas and rainstorms, disease of the respiratory tract, and understanding seawater dilution of respiratory samples collected for endocrine analysis. This also has implications for thermal imaging studies. The blowholes are recognized as a possible location on a whale from which high-quality body temperature readings could be collected from free-swimming whales. The presence/absence of water could change the thermal properties of the nares and affect temperature measurements during exhalation and inhalation. Using footage gathered from several years of UAV-based blow sampling of blue and humpback whales, along with recent anatomical studies on blowholes via necropsies, we investigated instances where water is entering the whales' respiratory system and if there is, in fact, a mechanism to mitigate the intrusion of water. We hypothesize that the nasal plug likely is rolling caudally and bulging dorsally as the nasal plug muscle relaxes, and this movement and geometry change forces the water back up and out of the nostril, even after the whale has submerged. This seals the upper respiratory tract, preparing it to be "water-free" for the dive. Upon surfacing the muscles withdraw the nasal plugs in preparation for surfing, allowing some water to enter the upper nares. This water is unlikely to penetrate further than the level of the base of nasal plugs, and is exhaled as the "spout."

Using UAV Footage from Blow Sampling to Investigate the Mechanism for Sealing the Respiratory Tract from Water in Large Whales

Chris Zadra¹, Iain Kerr², Andy Rogan², Alicia Pensarosa², Eric Angel Ramos¹, Joy S. Reidenberg, Ph.D.⁴

¹Ocean Alliance, ²Ocean Alliance, Gloucester, MA, ³The Graduate Center, City University of New York, BROOKLYN, NY, ⁴Icahn School of Medicine at Mount Sinai, New York, New York
The occurrence of humpback whales in Papahānaumokuākea Marine National Monument revealed by a Wave Glider autonomous surface vehicle

Eden Zang¹, Marc Lammers², Beth Goodwin¹, Anke Kügler⁴, Matt Harvey⁴, Jonathan Martinez⁶, Leila Hatch⁷

The National Oceanographic and Atmospheric Administration (NOAA) and the U.S. Navy are co-managing a multi-year effort (SanctSound) to monitor underwater sound within the National Marine Sanctuary System. The SanctSound effort is focused within seven national marine sanctuaries and the Papahānaumokuākea Marine National Monument (PMNM). Previous vessel-based surveys for humpback whales in PMNM have been limited due to harsh winter month conditions. As a result, many questions about the use by humpback whales of Monument waters have remained unanswered. Through a partnership with The Jupiter Research Foundation, a passive acoustic monitoring survey using a Wave Glider was conducted in PMNM waters between January and March 2020. The Wave Glider transited 2,627 nautical miles and made 92,408 1-minute recordings throughout the survey. The occurrence of humpback whale song in recordings was established using a machine-learning algorithm developed in partnership with Google. Analyses of the data revealed that humpback whale song was present at nearly every bank or shoal that the glider visited. Middle Bank, which lies just outside the boundaries of PMNM and is closest to the main Hawaiian Islands, had the highest prevalence of whale song. Song occurrence remained high between Nihoa and French Frigate Shoals before waning substantially at Gardner Pinnacles. Song occurrence increased again at Raita Bank, remaining high between Maro reef and the Northampton Seamounts. The results suggest a broad but somewhat clustered distribution of humpback whales across PMNM. Only sporadic whale song was detected in the waters between banks, even though the Wave Glider spent 77% of the mission transiting open waters. Thus, it can be concluded that, like in the main Hawaiian Islands, the shallow banks and shoals of PMNM play an aggregating function for humpback whales and therefore represent important winter breeding habitat for the north Pacific humpback whale population.

What Factors Affect the Survival of Harbour (Phoca vitulina) and Grey Seal (Halichoerus grypus) Pups Admitted for Rehabilitation in the UK and Ireland?

Michal Zatrak¹, Robyn Grant², Kirsty Shaw², Matt Geary³
¹Manchester Metropolitan University, ²Manchester Metropolitan University, Manchester, United Kingdom, ³University of Chester, Chester, Cheshire, United Kingdom

The UK shores are home to approximately 40% of the world’s population of grey seals (Halichoerus grypus) and 14% of harbour seals (Phoca vitulina). Although population numbers of H.grypus are increasing, some P.vitulina populations in the North East of the UK have displayed unexplained declines since the late 1990s. Both seal species encounter natural (e.g. disease) and anthropogenic (e.g. pollution) threats in their habitat that can result in seal strandings. Stranded seal pups are frequently rescued and admitted for rehabilitation. Rehabilitation centers keep comprehensive records that capture the major reasons for strandings, as well as intake weight, age, sex and
medication used. Studying rehabilitation records can, therefore, give us insights into the factors that affect the survival of seal pups. This study investigates the causes of *P. vitulina* and *H. grypus* admittance to rehabilitation centres in the UK and Ireland, and identifies factors that can affect seal pup survival. Rehabilitation records for 1643 *P. vitulina* and 2775 *H. grypus* pups were collected and transcribed from five rehabilitation centers from 1966 to 2020. The most common reasons for seal admission to rehabilitation centers included malnourishment (37%), injuries (37%), maternal abandonment (15%), lethargy (12%), and parasite infections (8%). A mixed effects logistic regression model showed that *H. grypus* had 78% higher odds of survival than *P. vitulina* and that the odds of a seal pup surviving to release increased by 9% for every kilogram over their age predicted weight. This weight-dependent survival is likely to be attributed to the importance of fat in thermoregulation, maintaining an optimal water balance and buoyancy during foraging. Overall, we recommend that seal rehabilitators should prioritise the weight of the seal pup during rehabilitation. This might include increasing feeding regimes in order to enhance their chance of survival and consequent release to the wild.

**Acoustic Crypsis via Habitat Selection in Southern Right Whales**

**Julia Zeh**¹, Julia Ribeiro Guimaraes Dombroski², Susan E Parks³

¹Syracuse University, ²Syracuse University, Brazil, ³Syracuse University, Syracuse, New York

Acoustically cryptic animals have adaptations which reduce the detectability of their acoustic signals. Most studies of acoustic crypsis focus on sound production and signal properties, but we propose that habitat selection is an additional adaptation which can confer crypsis. For example, animals can choose habitats with poor acoustic propagation in order to avoid detection. To test this hypothesis, we studied the acoustic propagation characteristics of Southern right whale calving habitats. Across populations, Southern right whale mother/calf pairs aggregate in shallow, sandy, nearshore waters. We modeled acoustic propagation of right whale calls in these environments using the Monterey Miami Parabolic Equation (MMPE) for three well-studied calving habitats across the southern hemisphere: De Hoop, South Africa, Ribanceira, Brazil, and Head of the Bight, Australia. We also modeled the propagation of killer whale calls, since killer whales are the primary predator of Southern right whales. Across all three study sites, our models showed that right whale calls from a nearshore Southern right whale would only be detectable out to 500m, while a killer whale calling offshore would be detectable out to > 5km. Thus, these particular habitats allow mother/calf pairs to remain acoustically cryptic while still listening for potential predators. This type of behavioral habitat selection for crypsis may occur in other baleen whale species with coastal calving grounds, such as humpback and gray whales. Future studies of habitat selection, both in baleen whales and other vocalizing taxa, should consider modeling the acoustic propagation characteristics of the environment.

**Using PAM to study the presence of bottlenose dolphins (T. truncatus) in the Gulf of Trieste, northern Adriatic Sea**

**Jure Zeleznik**¹, Natalija Žlavs², Tilen Genov³

¹Morigenos, Piran, Slovenia, ²Morigenos, Piran, Slovenia, ³Morigenos - Slovenian Marine Mammal Society, Piran, Slovenia, ¹Morigenos - Slovenian Marine Mammal Society, Portorož, Slovenia

The waters of the Gulf of Trieste in the northern Adriatic Sea are inhabited by common bottlenose dolphins (*T. truncatus*), the only regularly present species of marine mammals in this area. This population has been thoroughly studied since 2002 by Morigenos – Slovenian Marine Mammal Society through boat-based and land-based surveys, focal follows, photo-identification
and biopsy sampling. During 2020–2021, we deployed passive acoustic devices (C-PODs) at three ‘coastal’ and two ‘offshore’ locations in the Gulf of Trieste, to improve existing monitoring of bottlenose dolphins and get a better understanding the seasonal and diel patterns of their habitat use. Dolphin classification was performed using the KERNO echolocation classifier in the CPOD program. For further analysis we used only high and medium quality of echolocation click trains. To explain the potential relationship between the presence of dolphins and predictor variables (sample location, month, time of day, water temperature, angle of the hydrophone) we used a negative binomial generalized additive model (GAM) in program R. The highest number of recorded detections was at coastal location near the town of Piran, with 717 detection positive minutes (DPM) and the lowest at offshore location oceanographic buoy Zora with 41 DPM. The highest number of detections was in February (42 % of all DPM) and the lowest in October (0.45 % of all DPM). Almost half (44.4%) of DPM was during night time. The final GAM model included sample location, month of the year and water temperature. It explained 34.5% of deviance, with water temperature being the most important explanatory variable. Future long-term PAM at these locations will help us better understand the impacts of tourism, maritime traffic and other anthropogenic activities on the local marine biodiversity.

Meta-analysis of Seven Years of Citizen and Volunteer Marine Mammal Observations Collected via the Spotter Pro, Whale Alert, and Ocean Alert Family of Mobile Applications

Tess Hudson1, Virgil Zetterlind2, Jacob Levenson3, Scott Viers4

1Oceans Forward, Akureyri, Iceland, 2ProtectedSeas, Fort Walton Beach, FL, 3U.S. Department of Interior, Bureau of Ocean Energy Management, Plymouth, Massachusetts, 4Orca

Sound

Citizen scientists, researchers, and managers need integrated tools to streamline differently sourced data across national and oceanic scales to conserve marine species and make evidenced-based decisions. Fragmented citizen science programs with no singular data workflow for protected species makes it difficult, if not impossible, to use vast amounts of available data for environmental impact analysis. The Spotter Pro suite of mobile apps has been in use globally since 2014 across eight countries. The end-user free apps support the collection of both opportunistic and effort-based citizen science data. This mode of data collection is time efficient, reduces errors, and allows real time feedback on an international scale. We conducted a meta-analysis of all reliable data collected via the Spotter Pro, Whale Alert and Ocean Alert family of applications to assess the variety of users, how data were submitted, the species of interest and the geographic location. We examined several metrics to compare purpose of use, data output and variation across species and location. It was found collected data provided a vast array of population statistics, site fidelity practices, shifts in distribution and environmental factors. Main users consisted of researchers, citizen scientists and eco-tourism operators. Primary use of the apps was for scientific studies, public interest, and avoidance of ship strikes. Sightings concentrated mainly in the U.S with high usage in Iceland as well. The majority of sightings focused on humpback whales throughout all regions. The Spotter Pro family of applications create a channel which could be exploited by a vast array of citizen, scientific, conservation, and governmental organisations to increase knowledge and data sharing capabilities. They have the ability to increase the productivity of conservation efforts by providing robust, varied, and reliable data upon which evidence-based decisions can be made for the conservation of species.
Marine Mammal Morphometrics: 3D Model Estimation and Measurement Validation
Changqun Zhang1, Yujiang Hao1, Ding Wang2, Randall Davis3
1Texas A&M University at Galveston, Galveston, TX, 2Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan, China, 3Texas A&M University, Galveston, Texas

The Abstract of Metabolic rate of the endangered Yangtze finless porpoise was replaced as following (see attached PDF file for details). Morphometrics of mass and volume are vital to evaluate status of marine mammals adapted to the aquatic environment. The Blender 3D model is obtaining popularity in modeling external morphology of marine mammals for its realistic representation, and photogrammetry allows such applications on free-ranging animals. Although the promising application of 3D model was initiated over the truncated cone method, accuracy and significance of the Blender 3D model has not been validated with the direct measurements. In this study, we obtained direct measurements of total body volume and mass of eleven East Asian finless porpoises (Neophocaena asiaeorientalis sunameri) and photographed them using standardized photogrammetry. Blender 3D models were reconstructed from the same sets of images and then scaled with photogrammetric morphometrics for generating total body volume. Total body volume estimated with the truncated cone method using direct morphometrics as input were compared with volumes from the 3D model and directly measured volumes. The total body volumes generated from the 3D model differed significantly from the ones estimated by the truncated method, regardless of number of girths input (overall p value < 0.01) but were statistically no different from directly measured total body volume. Total body volumes estimated were distinct among the truncated cone methods when number of input girths were different. Performance of the truncated cone method improved when there were a greater number of girth inputs and significantly improved with photogrammetric morphometric input. The 3D model has potential to serve as the universal model with outstanding predictive performance (overall skill = 0.998, r = 0.998, P value < 0.01).

A Data Mining Perspective on the Intermittent Locomotion of Bottlenose Dolphins
Ding Zhang1, Yifan Wang2, Lisa Lauderdale3, Joaquin Gabaldon4, Lance Miller3, Kira Barton1, K. Alex Shorter Shorter1
1University of Michigan, Ann Arbor, MI, 2University of Michigan, 3Chicago Zoological Society, Brookfield, IL, 4Department of Mechanical Engineering, University of Michigan, Ann Arbor, Michigan

Intermittent locomotion composed of periods of active flapping/stroking followed by inactive gliding have been observed with species that inhabit both aerial and marine environments. Researchers have demonstrated that this locomotion pattern results in improved locomotion efficiency for certain fishes and birds, yet a physics based approach to characterizing the energetic cost benefits of a fluke-and-glide (FG) gait is lacking for cetaceans. This work presents a model to describe the FG gait as a two-phase process and quantify the associated mechanical energy costs of transport (MECOT) of bottlenose dolphins (Tursiops truncatus). This work also presents new estimates of gliding drag coefficients over a range of speeds for the model. The data-driven approach used 84 hours of biologging tag data from 3 animals to identify data segments for drag coefficients estimation and gait parameter characterization. A set of 532 qualified gliding events were mined out for gliding drag coefficient estimation, and an additional 478 FG bouts were parameterized and used to inform the model based energetic cost analysis. Results demonstrate that FG gait is used most frequently at a speed of 2.25 m/s with an average duty
factor of 0.46 and gliding duration of 5 sec. The associated MECOT of a FG gait is 0.319 J·m⁻¹·kg⁻¹, which is 27% lower than a corresponding bout of continuous fluking: 0.437 J·m⁻¹·kg⁻¹. These results support the supposition that FG gait enhances the swimming efficiency. Meanwhile, the identified bottlenose dolphin gliding drag coefficients and the proposed model can be applied to other studies that involve the kinematic analysis of the animals.

Stress-induced signaling impairs hypoxia tolerance in marine mammals
Larry Zheng¹, Jillian Wisse², Sarah Plumlee², Nicola Quick¹, Kathryn Ware¹, Nicolas Devos³, David Corcoran³, Zachary Swaim³, Thomas Schultz³, Andy Read³, Doug Nowacek³, Andreas Fahlman⁴, Heather Foley⁵, Danielle Waples⁶, Kim Urian¹, Jason Somarelli⁷
¹Duke University, Durham, NC, ²Duke University Marine Lab, Beaufort, NC, ³Duke University, Marine Lab, Beaufort, NC, ⁴Department of Medicine, Duke University Medical Center, Durham, NC, ⁵Duke Center for Genomic and Computational Biology, Duke University, Durham, NC, ⁶Duke University Marine Laboratory, Beaufort, NC, ⁷Duke University, Beaufort, North Carolina

Whales encounter substantial anthropogenic disturbances during their lifetimes. Despite this considerable exposure to stressors, little is known about the molecular mechanisms of the stress response in cetaceans and how this impacts gene expression programs that are needed for foraging, such as hypoxia tolerance. To address this, we sought to understand the molecular connections between stress and hypoxia. Here we use a systems-level approach to investigate the interaction between glucocorticoid signaling, the molecular stress response, and hypoxia. Using cell cultures from human (Homo sapiens) and five species of marine mammals - pilot whale (Globicephala macrocephalus), sperm whale (Physeter macrocephalus), humpback whale (Megaptera novaeangliae), bottlenose dolphin (Tursiops truncatus), and Cuvier’s beaked whale (Ziphius cavirostris), we analyzed differential interactions between the glucocorticoid and hypoxia gene regulatory networks across species. We found that hypoxia and glucocorticoid responses are highly interconnected and pinpointed key genes that functionally connect the stress and hypoxia gene regulatory networks. In particular, NR4A2, ADM, and LOX displayed high network connectivity and up/downregulation across the marine mammal species, suggesting key differences in gene interactions for cetaceans versus humans. To experimentally test the interaction of hypoxia and cortisol, cell cultures from a Cuvier’s beaked whale (Ziphius cavirostris) were treated with exogenous cortisol under normoxia and hypoxia. Addition of cortisol to cultures under hypoxic conditions suppressed the hypoxia response, suggesting that stress signaling may inhibit hypoxia tolerance. These results reveal novel insights on the molecular relationship of stress and hypoxia in marine mammals. This study has important implications for understanding the molecular mechanisms that underlie physiological responses of marine mammals when exposed to anthropogenic stressors.

Deriving Odontocete Acoustic Presence From Long-Term Recordings Around the Hawaiian Island Archipelago Using a Neural Network-Based Classifier
Morgan Ziegenhorn¹, Kait Frasier², John Hildebrand³, Erin Oleson³, Sean Wiggins³, Simone Baumann-Pickering⁴
¹Scripps Institution of Oceanography, UC San Diego, San Diego, California, ²Scripps...
The Hawaiian Island archipelago serves as a regional oasis in the generally unproductive waters of the North Pacific Subtropical Gyre, supporting at least 18 unique species of toothed whales (odontocetes). Between 2009 - 2021, a set of passive acoustic monitoring (PAM) recordings covering the frequency band of most odontocete echolocation clicks were collected by the NOAA Pacific Islands Fisheries Science Center (PIFSC) in this region. Due to the size of this dataset and the complexity of acoustic classification at the species level, multi-year, multi-species analyses have not yet been completed. To address this gap, we used a machine learning toolkit to derive timeseries of acoustic presence for 10 species of odontocetes over the past decade in the Hawaiian Island archipelago. We focused our classification efforts on echolocation clicks as they are produced in a wide variety of behavioral states and seem to have less intraspecific variability than other vocalization types. Unsupervised clustering methods were used to establish a set of echolocation click ‘types’ for recordings collected from bottom-mounted hydrophones off of Hawaii and Kauai, and at Pearl and Hermes Reef. These automated labels were compared with known records for species with established and recognizable clicks, which allowed for ground-truthing of some click types identified by the unsupervised machine learning method. A neural-network based classifier was trained and tested using these click types as input classes. This classifier was then applied to all recordings to produce timeseries of acoustic presence, which will be used for spatiotemporal comparisons. The methods applied here are particularly efficient for the analysis of large PAM datasets. The classifier and timeseries produced will facilitate further analyses of spatial and temporal patterns of odontocete presence in the region, particularly with respect to the habitat preferences and behaviors of the species considered.

Do Indo-Pacific bottlenose dolphins self-medicate with invertebrates in coral reefs?

**Angela Ziltener¹, Gertrud E. Morlock¹, Franz Brümmer¹, Jennifer Tersteegen¹, Sascha Geyer¹, Annabel Mehl¹, Tamara Schreiner¹, Tamer Kamel¹**

³Dolphin Watch Alliance; University of Zurich - Department of Anthropology, Zurich, Zurich, Switzerland

Wild Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) have been observed queueing up in natural environments to rub various body parts against specifically selected corals and sponges in the Northern Red Sea of Egypt. We hypothesized that the presence of bioactive metabolites could account for this selective rubbing behaviour as a form of self-medication. Three marine organisms explicitly accessed by the dolphins were investigated for the presence of antibacterial, antioxidative, cholinesterase inhibiting, anti-/estrogenic, anti-/androgenic and genotoxic compounds. Seventeen bioactive metabolites were discovered produced by the gorgonian coral *Rumphella aggregata*, the leather coral *Sarcophyton* sp. and the sponge *Ircinia* sp. or their symbionts. Some of these were assigned to known natural products (proof of principle), others were unidentified. Repeated rubbing allows these active metabolites to come into contact with the skin of the dolphins and be useful for prophylaxis or auxiliary treatment against microbial infections. This interdisciplinary research in dolphin behaviour, separation science and effect-directed assays showed that the importance of these invertebrates in coral reefs should not be underestimated. This study highlights the urgent need to protect coral reefs for dolphins and other marine species and calls for further studies on invertebrate-vertebrate interaction.
Acoustic environment of deep diving cetaceans

Walter Zimmer, CMRE, La Spezia, Italy

Deep diving cetaceans, especially sperm and beaked whales, are living in a world of their own. They are known to forage consistently at great depth where they spend a significant amount of time. Despite being wide ranging animals, sperm and beaked whales also show some preference to underwater canyons and sea mounts. In summer 2021, three deep-sea sound recorders were placed in the vicinity of the Caprera Canyon, north-east of Sardinia in the Mediterranean Sea to monitor the presence of deep divers and to assess the acoustic environment these animals encounter while foraging in this habitat. The Caprera Canyon is recognized as an Area of Interest (AoI) by the IUCN Marine Mammal Protected Area Task Force and the sound recorders were deployed to support the initiative of the One Ocean Foundation to have this Caprera Canyon AoI be recognized as an Important Marine Mammal Area (IMMA). The recorders were moored at water depths between 680 to 900 m and were sampling continuously the acoustic environment in the frequency band up to 48 kHz allowing the observation of echolocation clicks of deep divers, whistles and clicks of dolphins, and broadband noise of passing ships from close-by shipping lines and fishing activities.

The recorders were implemented as compact volumetric acoustic sensors using 6 hydrophones spaced by 69 mm in a volumetric configuration providing three-dimensional sound intensity estimation and direction-finding capabilities supporting the analysis of habitat usage of deep diving cetaceans.

This presentation describes and discusses the first results obtained in terms of cetacean and anthropogenic presence and characterizes the observed acoustic environment.

Large Whale Distribution And Density In The New York Bight From Monthly Aerial Surveys 2017-2020

Ann Zoidis¹, Kate Lomac-MacNair², Darren Ireland³, Meghan Rickard⁴, Matthew Schlesinger⁵, Kim McKown⁶

¹Tetra Tech/ Cetos Research Organization / Allied Whale, Bar Harbor, Maine, ²CCMAR, Universidade do Algarve, Frita Creek, Alaska, ³LGL Ecological Research Associates, Bozeman, Montana, ⁴New York Natural Heritage Program; New York State Department of Environmental Conservation, Mount Sinai, NY, ⁵New York Natural Heritage Program, College of Environmental Science and Forestry, Albany, NY, ⁶New York State Department of Environmental Conservation, East Setauket, NY

This multi-year study investigated the density and distribution of six large whale species in the New York Bight (NYB), including the blue whale (Balaenoptera musculus), fin whale (B. physalus), humpback whale (Megaptera novaeangliae), North Atlantic right whale (Eubalaena glacialis), sei whale (B. borealis), and sperm whale (Physeter macrocephalus). Monthly line-transect aerial surveys were conducted in the NYB from 2017-2020 (36 total surveys) focused on these six large whale species. A total of 318 sightings of large whales (629 individuals) were recorded and sighting rates varied by season and distribution zones. The combined density of the six species, uncorrected for detectability on the survey line (g[0]), was 1.7 individuals/1,000 km², and average annual abundance was estimated to be 76 whales (coefficient of variation [CV] = 21.2%) in the NYB survey area. When species-specific corrections for trackline detectability bias were applied, the overall density estimate increased to 6.3 individuals/1,000 km², resulting in an average annual abundance estimate of 272 whales. After pooling all data, the annual average densities corrected for detectability bias were as follows: blue whale, 0.03 individuals/1,000 km²;
fin whale, 2.9 individuals/1,000 km²; humpback whale, 2.5 individuals/1,000 km²; North Atlantic right whale, 0.3 individuals/1,000 km²; sei whale, 0.08 individuals/1,000 km²; and sperm whale, 1.3 individuals/1,000 km². Humpback and fin whales are the most common and occur in greater numbers than the other four species. Findings from three years of survey provide a basis for management and conservation efforts in the NYB and valuable baseline data for the evaluation of current measures to protect large whales from anthropogenic threats like fishing, shipping, and offshore wind development in the NYB.