COLLEGE OF AGRICULTURAL SCIENCES

MARINE MAMMAL INSTITUTE

MMI.OREGONSTATE.EDU

2023

Oregon State University

In this issue:

Director's Message

LISA T. BALLANCE PHD, DIRECTOR

I love this time of year — for many reasons. In the context of this newsletter, it is the time when I step back and take a 10,000-foot view of MMI — reviewing the past, looking forward to the future.

It is my fourth anniversary as director of the Marine Mammal Institute. When I first arrived, we were a group of four labs and 30 people. We were dispersed among five buildings across the Hatfield Marine Science Center. Our research vessel *Pacific Storm* was beginning a year-long intensive maintenance and inspection period. The global pandemic came six months later, and the world closed down for the better part of two years.

Lisa Ballance scans for marine mammals from the crow's nest of the R/V Pacific Storm *during the fourth MOSAIC research cruise this October.*

Even so, MMI thrived. We hired two new tenure-track professors and lateraled an existing research professor into a third tenure-track position. We implemented MMI affiliate principal investigators based on existing and new collaborations. Our graduate student body and post-doctorates grew. A newly refurbished *Pacific Storm* began to go to sea again. We created a graduate student awards program and began to use proceeds from Oregon's gray whale license plates to fund research and students. We moved into our new Gladys Valley Marine Studies Building. We hired yet another tenure-track professor.

I am proud to be the successor of Dr. Bruce Mate, the founder of our institute. His work through the past four decades set the stage for the astonishing growth that MMI has experienced these past four years, and he and I have developed a deep partnership in planning the future of our institute. Today, we are seven labs and 60 strong, with expertise ranging from molecular markers to food web connections and study sites locally and globally, all using and developing state-of-the-art technology in the lab and in the field. As one of the largest and most impactful marine mammal focused research and education entities in the world, our collective power means that we can conduct complex, multidisciplinary research entirely within MMI and multiply that power through attracting collaborators from around the globe.

We need this power. Even as many marine mammals continue to recover from industrial whaling around the globe, we humans are using and needing the ocean in new ways. That bring challenges in sustainability and unanticipated conflicts with marine mammals. Solving these problems will require innovation, collaboration, and raw talent.

And so, I increasingly turn my sights toward the future. I want to ensure that MMI retains its scope, impact, and ability to address inevitable changes in problems affecting marine mammals, the oceans in which they live, and the humans that depend on the oceans. The nature and timing of these challenges are unpredictable. In the face of this unpredictability, my focus is on resilience and nimbleness.

How do we ensure that? Through our people — the cornerstone of everything we do. I have a vision that ensures MMI retains its world-class talent and continues to attract the best and the brightest. That vision is articulated as an inset with this newsletter. It's all about people. And that includes all of you.

What a thrill it has been to work with you all to make such an impact. Please take pride in reading this newsletter. Join me in continuing to magnify this power. ***~Lisa***

Celebrating Excellence

KC BIERLICH

KC Bierlich (pictured below, at left) was awarded the 2023 Excellence in Undergraduate Research Mentoring by a Postdoc Award from the OSU Graduate School. This award recognizes outstanding undergraduate research mentoring by OSU postdoctorates who had direct and significant involvement with undergraduate student researchers, a demonstrable commitment to the research mentorship of undergraduate students, and a record of effectiveness and impact with respect to undergraduate student research and success. Dr. Bierlich is a postdoctoral scholar working with Associate Professor Leigh Torres.

DEBBIE STEEL

Debbie Steel (pictured above, at right) was selected as the 2023 recipient of the Outstanding Faculty Research Assistant Award by the Faculty Recognition and Awards Committee of the Faculty Senate. Debbie has been the lab manager for Professor Scott Baker for 22 years.

ALLISON DAWN

Allison Dawn (pictured above) was awarded her Master of Science degree in wildlife science on June 29 after successfully defending her thesis, "Intermittent upwelling impacts zooplankton and their gray whale predators at multiple scales." Allison has led the past three summers of the gray whale foraging ecology project in Port Orford, Oregon. She was advised by Associate Professor Leigh Torres.

ANGELA SZESCIORKA

Angela Szesciorka was selected as a 2023 recipient of the OSU Postdoctoral Excellence Award. This award is granted annually to two postdoctoral scholars, fellows, or research associates for their exceptional contributions to their research field, OSU, and the greater postdoctoral community. Dr. Szesciorka is a research associate working with Associate Professor Kate Stafford.

MORGAN O'ROURKE-LIGGETT

Morgan O'Rourke-Liggett presented their thesis, "Standardization of Gray Whale Survey Effort to Calculate Area Surveyed Per Day," on May 31 and earned a Professional Science Master's degree in fisheries and wildlife administration. Morgan was advised by Associate Professors Daniel Palacios and Leigh Torres.

KATE COLSON

On August 22, Kate Colson (pictured at left) successfully defended her thesis, "Estimating the relative energetic cost of foraging in Pacific Coast Feeding Group gray whales from biologging data." Kate has been co-advised by Leigh Torres (Marine Mammal Institute) and Andrew Trites (University of British Columbia). Kate earned a Master of Science in oceans and fisheries from the University of British Columbia.

Musings on the Circle of Life

JIM RICE, STRANDING PROGRAM MANAGER

This past February, I had the amazing opportunity to be part of part of the annual MMI Baja Gray Whale Expedition. This experience involved multiple close encounters with gray whales in their winter calving grounds, the protected sanctuary of San Ignacio Lagoon, Baja California Sur, Mexico.

During multiple outings in small boats, the whales would frequently and voluntarily approach us. They seemed to invite interaction, sometimes by playfully rubbing their backs along the bottoms of our pangas, gently lifting and lurching the small boats and splashing us with underwater explosions of their exhaled breaths, eliciting shrieks of surprise and delight from those of us onboard. Witnessing the curiosity and trust that these whales — often mothers with their young calves — displayed toward us was a truly unique and incredible experience.

But as it happens, the peaceful safety of the lagoon could only be an ephemeral luxury for these gentle giants, as they would all soon be leaving these protected waters for foraging grounds in higher latitudes. Their northward migratory route is long and perilous, particularly for the ongoing risk of predation from killer whales.

Many of us living and working along the Oregon coast have been thrilled by numerous sightings of killer whales in recent years. Word of their presence close to shore spreads quickly, as people scramble to track and document the whales' movements into estuaries such as Yaquina Bay in search of their pinniped prey.

There's something humbling and awe-inspiring about witnessing these large apex predators up close, and it's not uncommon to hear people openly rooting for their foraging success. Many in our community believe that there are "too many" seals and sea lions and that their populations ought to be reduced in size. Having predators doing their job to check abundant populations of harbor seals and Californina sea lions can be exciting to contemplate and to many seems preferable to having them be culled by human means.

But pinnipeds make up only part of the killer whales' diet along the Oregon coast. Gray whales, and particularly the vulnerable calves, are an important prey type for them as well.

In late March, I personally witnessed an attack on a pair of gray whales by a group of killer whales just offshore of Yaquina Head, near Newport. As I watched through binoculars from the headland for about an hour, the killer whales were relentless, making repeated efforts to subdue the larger gray whales by pummeling them with their tail flukes and lifting their bodies above the gray whales' heads in an effort to hold them underwater to prevent them from breathing. As sunlight faded and the fog rolled in, I lost sight of them. It was frustrating to leave the site unsure of the outcome of this predation event,

Below: Killer whales prey upon a gray whale calf off Otter Rock, Oregon, on May 8, 2023. Photo by Craig Hayslip

Above: Graduate student Charles Nye exchanges glances with a gray whale calf in San Ignacio Lagoon, during the Baja Gray Whale Expedition. Photo by Jim Rice.

although I was also a bit relieved not to witness this violent scene any longer.

Several weeks later, another killer whale attack on two gray whales (a mother and her calf) was observed from shore just off Otter Rock by many onlookers. The event was documented by a flying drone, with the resulting video posted and shared widely on social media. The outcome of this event was clear to many who observed it: despite the gray whale mother's steadfast hours-long efforts to defend her calf, it was finally observed lifeless and being consumed by the killer whales.

The carcass of this calf came ashore a few days later, with clear evidence of major trauma caused by the killer whales. In subsequent days, two more gray whale calves, which had suffered a similar fate, were found and examined along the Oregon coast (one at Heceta Head near Florence and another on the north coast at Gearhart).

Responding to marine mammal strandings is sobering work. It invariably involves examining animals that have reached the end stages of their lives. We humans try to determine causes of their injuries, diseases, and deaths. The signs of killer whale predation have been increasingly obvious on both the pinniped and large whale carcasses that I've examined in recent years, a growing indication that these large predators are active and present in our local waters.

Witnessing predation events involving such charismatic megafauna reminds me of watching Mutual of Omaha's *Wild Kingdom* on TV as a kid. This show would often feature vivid scenes of predators such as lions killing and consuming large prey, such as zebras. Watching these dramatic contests over life and death had a lasting effect on me, and to this day I often think of predation events as "Wild Kingdom moments."

It can be difficult to watch these natural processes play out in real life, particularly when we've developed a personal affinity for the prey. For me, these feelings are tempered by the knowledge and appreciation that every organism has its own ecological role to play. As a bystander quipped to me while I was examining a recently killed gray whale calf this past spring, "Everyone's gotta eat." ***MMI***

The Oregon Marine Mammal Stranding Network is Jim Rice, Maya Bingham, Debbie Duffield (Portland State University), Seaside Aquarium, and a host of volunteers who live along the Oregon Coast.

Size, Shape, & Strategy

LEIGH TORRES PHD, ASSOCIATE PROFESSOR

Does function drive form, or does form drive function? This is the classic ecological "chicken-and-egg" question. While there is no simple, consistent answer, we do know that the two are intimately linked. Thus, when studying wild animal populations to better understand how they live, it is important to document morphological differences that may exist between individuals or populations as these differences can provide critical clues about their health and ecology.

NOT SO PYGMY

We often joke in the GEMM Lab that you can't publish a paper on blue whales without including the phrase, "the largest animal ever to live." While this fact primarily refers to the behemoth Antarctic blue whale measuring up to 30 meters (~100 feet), there are many distinct populations of blue whales. Are they all the same size? Why would they be different sizes and what does it mean for their population's health? To address these questions, we investigated how the morphology of blue whales relates to oceanography and feeding strategies on the foraging grounds of three different blue whale populations: Eastern North Pacific blue whales feeding in Monterey Bay, California; Chilean blue whales feeding in the Corcovado Gulf; and New Zealand blue whales feeding in the South Taranaki Bight. We obtained photogrammetry measurements from aerial drone images of whales collected in these three study systems to calculate length, fluke span, skull size, and overall body condition (fat or skinny).

While blue whales that feed in Monterey Bay and Corcovado Gulf migrate to and from these seasonally productive feeding grounds, the New Zealand population has a different life history strategy of staying in the South Taranaki Bight year-round. These New Zealand blue whales belong to a subspecies called "pygmy blue whales," which implies they are smaller than the rest; however, our analyses determined that all three blue whale populations have the same body length (~22 m; 72 ft), begging us to say, "Not so pygmy!" The results got juicier as we determined that the New Zealand blue whales were in better body condition (fatter) despite lower productivity of their foraging ground, potentially because their nonmigratory strategy allows them to be ready for feeding opportunities when they arise. In contrast, the migratory strategy of the Eastern North Pacific and Chilean populations requires good timing to access abundant prey when it occurs.

Above: A surface-feeding blue whale lines up a mouthful of krill in the South Taranaki Bight of New Zealand. Drone image captured by Todd Chandler.

We also found differences in skull and fluke size between all three populations, potentially related to feeding behaviors adapted to region-specific prey characteristics. While all three blue whale populations feed on krill, these are three different species of krill with different ecological patterns. The krill in New Zealand frequently swarm at the surface. Blue whales in this ecosystem do more surface feeding than the other populations, so bigger flukes may be advantageous to overcome increased buoyancy at the surface. These morphological differences between blue whale populations may represent trade-offs between maneuverability and efficient long-distance migration that favors a more sleek, narrow body form.

Taken together, our collaborative analysis demonstrates that not all blue whales have the same body shape, and these differences may relate to each population's foraging and life history strategy. Our work indicates that as oceanographic

patterns and prey resources shift under climate change, blue whale populations may show vulnerabilities and resilience that relates to differences in migratory patterns, feeding behavior, and morphology.

Funding for this project was provided in part by an anonymous donor of the Orange County Community Foundation.

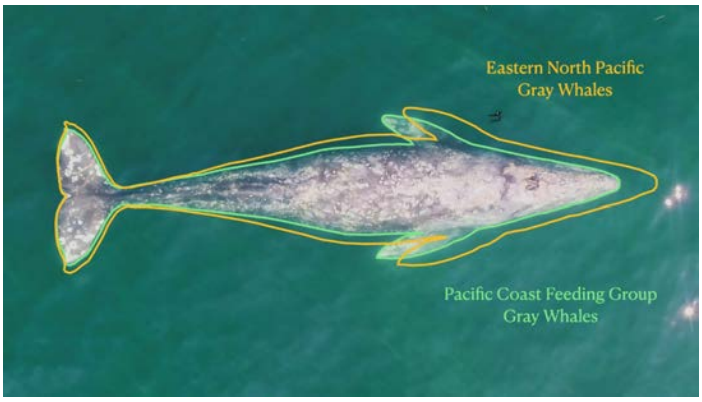
DOWNSIZED

If you're lucky enough to visit or live along the Oregon coast during summertime, then you may have seen gray whales feeding in the very nearshore areas of our beautiful coastline. This group of gray whales is called the Pacific Coast Feeding Group (PCFG) because they feed along the coast between Northern California and British Columbia instead of making the traditional migration all the way up to Arctic or Subarctic foraging grounds like gray whales in the Eastern North Pacific (ENP) population.

PCFG whales also feed on different prey (mysids, crab larvae), in different habitat (shallow, rocky reefs), using different foraging tactics (headstands, upside-down swimming) from ENP gray whales. So, are PCFG whales the same as ENP gray whales, and how does their different foraging strategy affect them? Answers to these questions are important for effective conservation management of gray whales, particularly PCFG whales that are currently considered part of the ENP population.

We have collected aerial drone imagery of PCFG gray whales in Oregon waters since 2016 enabling us to accurately measure each whale's length, skull size, fluke size, and overall body condition. We compared these body condition values to gray whales foraging in the Arctic and arriving to wintering grounds in Baja California, Mexico, and we documented that PCFG whales are significantly skinnier than these ENP gray whales.

Below: Postdoctoral Scholar KC Bierlich pilots a drone with Leigh Torres from the GEMM Lab's small and mighty research vessel, Ruby.



Above: Drone photogrammetry shows differences in length, skull size, and fluke size between ENP (yellow) and PCFG (green) gray whales.

Furthermore, we documented that PCFG whales are shorter than ENP whales. Using photo-identification data of PCFG whales to obtain information on each individual's age, we generated a growth curve that describes how long whales typically are at each age. For comparison to ENP whales, we generated a growth curve using length and age data from strandings, whaling, and aerial photogrammetry. We found that while PCFG and ENP whales have similar growth rates, PCFG whales reach smaller asymptotic (final) lengths than ENP whales: Females average ~1 m (3 ft) shorter and males average ~0.5 m (1.5 ft) shorter. Additionally, PCFG whales have relatively smaller skulls and flukes than ENP whales.

So why are PCFG whales shorter and skinnier? Does this make them better adapted to feeding in shallow habitat? Do they need less energetic storage in blubber since they migrate half as far? Or is their food less abundant and energy-rich, limiting the growth of PCFG whales? Furthermore, are there consequences of this different morphology, such as producing fewer calves or being less resilient to disturbance and injury? Unlike ENP whales, PCFG whales spend about six months each year foraging in human-influenced areas filled with vessel traffic, fishing gear, pollution, and noise. Given this difference in exposure to human activities and the size differences between ENP and PCFG whales, it may be time to reevaluate gray whale population designations and consider the PCFG as a separate management unit that may require distinct management strategies.

This project was supported by NOAA/NMFS, Office of Naval Research, Department of Energy, Oregon Sea Grant, and Marine Mammal Institute. ***MMI***

The GEMM Lab is Leigh Torres, Solène Derville, KC Bierlich, Dawn Barlow, Alejandro Fernández Ajó, Lisa Hildebrand, Clara Bird, Rachel Kaplan, and Nat Chazal.

Marine Mammals in Context

JOSHUA STEWART PHD, ASSISTANT PROFESSOR

Ocean Ecology Lab

Marine mammals can be top predators, exerting top-down influence on their ecosystems, or consumers of massive quantities of tiny prey, sensitive to natural and climate-driven fluctuations in the environment. The ways in which marine mammals affect — or are affected by — their environment, in tandem with ubiquitous human impacts on species and ecosystems, are largely responsible for the health and population trends of these threatened and recovering species.

At the Ocean Ecology Lab, we strive to understand marine mammal populations in the context of the ecosystems they inhabit. We study the interactions between marine mammals and their prey, how these interactions are influenced or disrupted by human activities, and what this means for the current status and future of marine mammal populations.

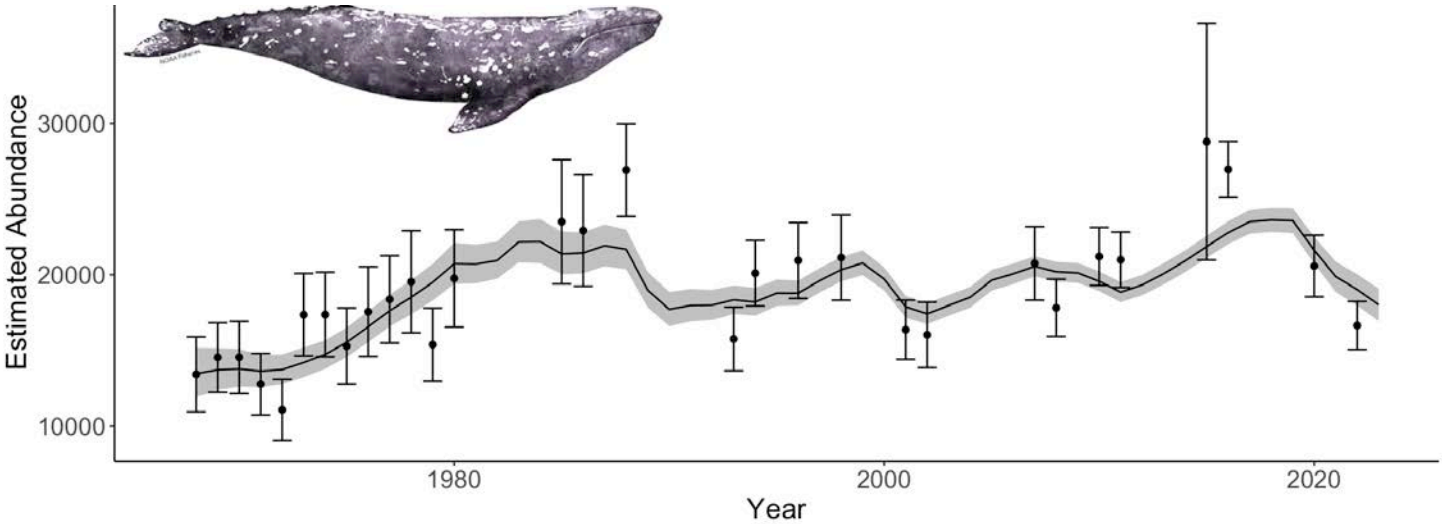
SALMON ARE KING

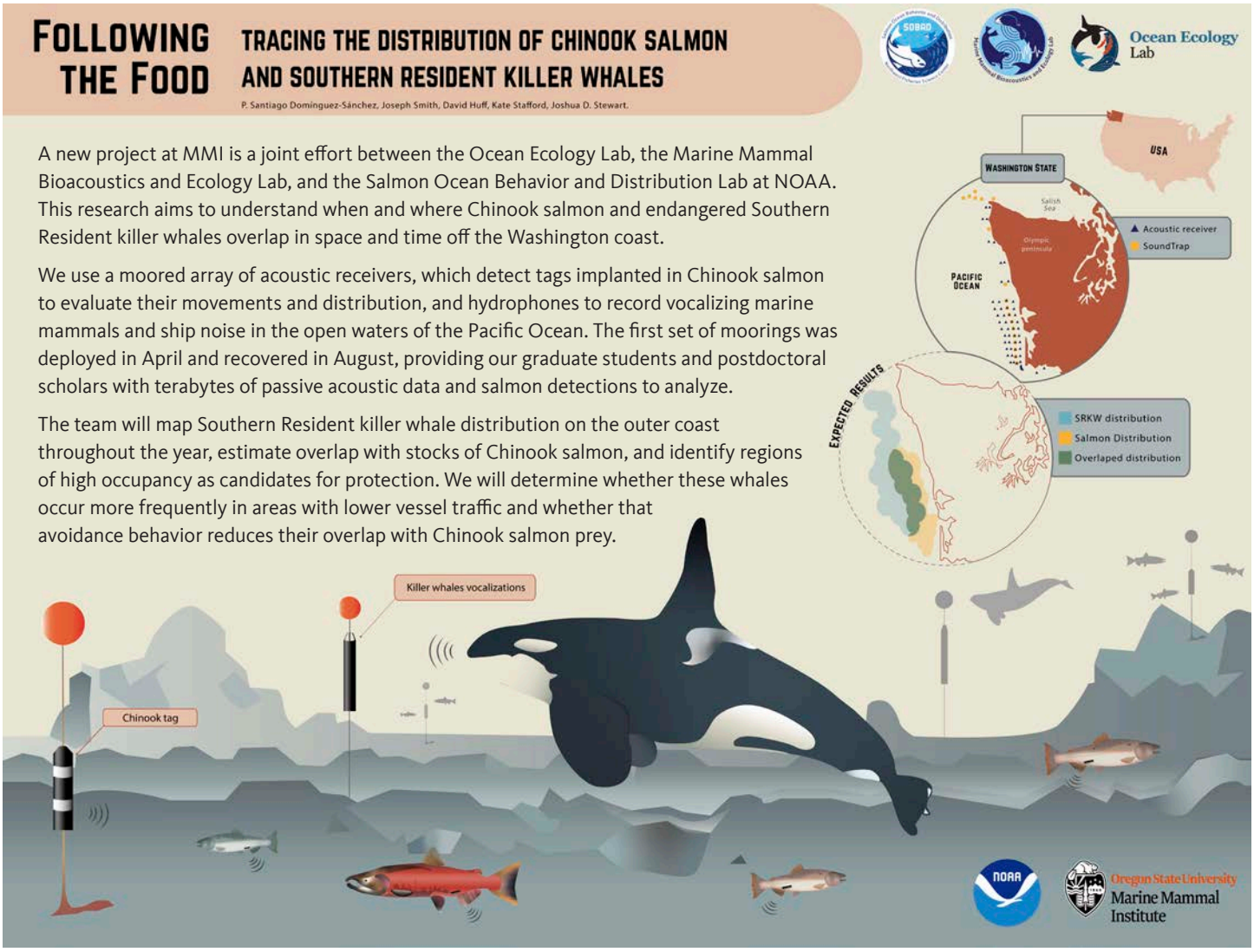
In the Pacific Northwest, salmon have immense value both for marine ecosystems and human communities, which can create challenges for management. Several marine mammal species are consumers of salmon off the coasts of Oregon, Washington, and British Columbia, which makes understanding salmon population dynamics an essential part of developing effective marine mammal management strategies.

Perhaps the most iconic salmon-eating marine mammals are the Southern Resident killer whales, an endangered population that feeds almost exclusively on Chinook (King) salmon. We are working closely with collaborators from NOAA to understand how the abundance and trends of different Chinook salmon stocks — many of which are also endangered — influence the population dynamics, movements, and behavior of these whales.

While Southern Residents are beloved by the public, other salmon-consuming marine mammals have a more complicated story. Sea lions and harbor seals have made stunning recoveries over the past 50 years since receiving protection under federal law. These species also consume salmon and have been blamed for depleting salmon populations as their numbers have increased. We are seeking to understand just how much of an impact seals and sea lions have on salmon populations using a variety of approaches. Clarissa Teixeira is leading a project with Jim Rice and the Oregon Marine Mammal Stranding Network using stable isotope analysis of harbor seal whiskers to estimate what proportion of harbor seal diets come from juvenile salmon and what factors influence how much salmon they eat.

Below: The estimated abundance of gray whales has fluctuated significantly over the past 50 years, after a rapid recovery from whaling that lasted through the 1980s. The major mortality events starting in 1988, 1999, and 2019 were associated with reduced prey and reduced access to feeding areas in the Arctic.





Dylan Gomes worked in collaboration with partners at NOAA to study the food web dynamics of the Northern California Current. This work examined the potential effect of increasing pinnipeds, seabirds, and whales on salmon and other important ecosystem components and found that factors such as climate change that affect the base of the foodweb have a far greater impact on salmon than predation by seals and sea lions. In addition, Dylan explored the effects of two recent marine heatwaves and found dramatic changes to ecosystem structure as a result of rapid warming, with species lower on the food chain experiencing the greatest impacts.

RECOVERING IN A CHANGING WORLD

In a study recently published in *Science*, Josh Stewart worked with colleagues from NOAA to understand the population dynamics of gray whales and how post-whaling recovery is interacting with climate change and Arctic ocean conditions to drive major population swings. The team found that after a rapid recovery through the 1980s, the gray whale population began experiencing severe die-offs every 10–20 years in response to variable Arctic conditions. Major mortality events were caused by periods of low crustacean biomass (gray whales' primary prey, which live on the seafloor) and high sea ice, preventing them from reaching their primary feeding areas.

The most recent mortality event, which began in 2019, has lasted longer than previous events, leading to a greater overall decline in abundance and is likely a sign of climate-related impacts to the population. This work shows that large whale populations may be more sensitive to environmental fluctuations and changes in prey availability than previously thought and provides a window into the future of large whale populations as they recover to their pre-whaling population sizes. ***MMI***

The Ocean Ecology Lab is Josh Stewart, Clarissa Teixeira, Dylan Gomes, Erica Mason, Santiago Domínguez Sanchez, Ally Kane, and Charlene Pérez Santos.

Meet the Wave Makers

Today's Students, Tomorrow's Scientists

KYRA BANKHEAD

MS student (Cantor)

Drivers of maladaptive behavioral propagation of human-centric foraging tactics in bottlenose dolphins

CLARA BIRD

PhD candidate (Torres)

Patterns of gray whale behavior across space, time, and the individual

NATALIE CHAZAL

PhD student (Torres)

Prey-scape characterization and health of Pacific Coast Feeding Group gray whales

PABLO SANTIAGO DOMÍNGUEZ SANCHEZ

PhD student (Stewart)

Distribution and population dynamics of Southern Resident Killer Whales

LISA HILDEBRAND

PhD candidate (Torres)

Individual foraging and habitat use patterns of Pacific Coast Feeeding Group gray whales

MICHAELA KRATOFIL

PhD student (Palacios)

Movement ecology of Hawaiian false killer whales

LADD IRVINE

PhD candidate (Palacios)

Bridging the gap: Linking rorqual foraging ecology across multiple scales

ALLY KANE

MS student (Palacios, Stewart)

Foraging ecology of humpback whales in breeding grounds using satellite telemetry

IMOGEN LUCCIANO

MS student (Torres)

Acoustic behavior, abundance, and distribution of Oregon coast cetaceans

RACHEL KAPLAN

PhD student (Torres)

Krill ecology structures rorqual whale distributions in space and time

KELLY LIZEWSKI

MS student (Baker)

Population structure of Gulf of Mexico sperm whales

ALYSSA LOPEZ

MS student (Stafford)

Acoustic studies of killer whales off the Washington Coast

LIAM MUELLER-BRENNAN

MS student (Palacios)

Stable isotope ecology of satellite-tagged humpback whales in the North Pacific

CHARLES NYE

PhD student (Baker)

Ecological metagenomics, environmental DNA, and marine mammal stranding response

EMMA PEARSON

PhD student (Stafford)

Impacts of offshore wind energy on wildlife in US West Coast waters

CHARLENE PÉREZ SANTOS

MS student (Stewart, Palacios)

Understanding the Impact of Vessel Traffic on Humpback Whales in Mexico

MAHMUD RAHMAN

MS student (Cantor)

Risk-taking behavior among bottlenose dolphins in the Lower Florida Keys.

HANNAH SAWYER

MS student (Stafford)

Acoustic behavior of bowhead whales in a prey hotspot in the Arctic

SHANTA SHAMSUNNAHAR

PhD student (Ballance)

Modelling cetacean bycatch in small-scale fisheries with human dimensions

Ch-ch-changes in the Arctic

KATE STAFFORD PHD, ASSOCIATE PROFESSOR

It has been a busy and productive year in the Marine Mammal Bioacoustics and Ecology Lab! We're adding two new graduate students, Alyssa Lopez and Emma Pearson; bringing on two post-doctoral scholars, Taylor Hersh and Hannah Myers, jointly with LABIRINTO and Ocean Ecology Lab; and branching out beyond bioacoustics to include stable isotope studies with postdoctoral scholar Clarissa Teixeira.

In last year's newsletter, we introduced some of the Arctic-centric projects we were working on. This year, I'm pleased to report that we have some interesting results that have advanced our understanding of the impacts of climate change in the Arctic. We've made new discoveries about changing migration patterns of an Arctic endemic species, the superlative bowhead whale, and two subarctic species, a potential predator (killer whales) and competitor (the humpback whale).

BOWHEAD WHALES

Bowhead whales are an important top predator in the Pacific Arctic. With increasing temperatures and decreasing sea ice, we suspected that the migration patterns of this "ecosystem sentinel" were changing.

Postdoctoral scholar Angela Szesciorka analyzed acoustic data from the Bering Strait, western Beaufort Sea, and Chukchi Plateau from 2008 to 2022. We found basin-wide changes in bowhead whale migration over the course of ten years. Some whales are now spending winter in the southern Chukchi Sea rather than the northwestern Bering Sea. Whales are also delaying their fall departure from the western Beaufort Sea and spending more time in the Chukchi Plateau, a suspected previously unknown summer foraging ground.

NEW NEIGHBORS

It's not just Arctic species that are changing their migratory timing and locations. Master's student Hannah Sawyer has been investigating killer whale presence in the Pacific Arctic. She found a steady increase in acoustic detections of orcas in data recorded from hydrophones (underwater microphones) along northern Alaska over the past two decades. This rise in acoustic detections, coupled with local observations of animals, suggests an increase in orca presence in the Beaufort Sea, a region that was previously inhospitable to killer whales due largely to its lengthy ice-covered season.

Above: Four bowhead whales surface in the ice off Utqiagvik in spring 2023. Photo by Kate Stafford, MMI.

Remaining north may protect calves from killer whales and reduce the risk entanglement in commercial fishing gear from Bering Sea fisheries. However, a shift north may put whales in more of a direct path of ships, especially along the western side of the Chukchi Sea.

This research was published in *Movement Ecology* earlier this year. Our findings have been featured in 22 newspaper and television interviews, including Oregon Public Broadcasting, The Arctic Sounder, Anchorage Daily News, and KTUU-TV.

Although there have been occasional reports of orcas in the past, routine presence of this apex predator could foreshadow an ecological shift in the

Above: Graphical abstract describing our results. Artwork by Clarissa Teixeira.

Beaufort Sea. Most Arctic marine mammals have evolved with little to no predation pressure beyond that from humans, and the introduction of a new threat may change Arctic ecosystem dynamics.

Another subarctic whale, the humpback whale, is likewise making an appearance in the northern Chukchi and Beaufort Seas. Humpback populations in both the North Pacific and North Atlantic have made remarkable recoveries since industrial whaling and were increasing by 8%–9% per year, although this may have slowed down in recent years. Increases in these populations result in animals reoccupying old, and potentially moving into new, habitat.

Over this same time, the Arctic has been warming, illustrated best by extreme sea ice retreat in fall, which opens further habitat to humpback whales and other temperate species, including killer whales as mentioned above. We combined data from shipboard and aerial survey sightings and reports from coastal residents to piece together when and where humpback whales have been seen north of the Arctic circle. By speaking with local hunters and Native Inupiat speakers, we determined that these animals, including mothers and calves, are now increasingly seen feeding just offshore of Utqiaġvik, Alaska.

This research appeared in *Marine Mammal Science* in June. During the past three field seasons on a krill–bowhead project in the Beaufort, we've seen humpback whales every year — a first for Kate, who has spent many hours at sea in this region and season and had never seen a humpback there until 2021. Early in the fall 2023 field season, we had seen as many humpbacks as bowhead whales — clearly a sign that they are there to stay. ***MMI***

MMBEL is Kate Stafford, Angela Szesciorka, Emma Pearson, Hannah Sawyer, and Alyssa Lopez.

BLUE WHALES IN THE SEYCHELLES

KATE STAFFORD

In November 2021, Kate Stafford and Ladd Irvine took part in a research voyage aimed at finding and identifying a population of blue whales in the Seychelles, with colleagues from Florida International University, University of the Seychelles, and a film crew.

Historically, the Seychelles archipelago was an opportunistic whaling ground for fleets en route to and from the Antarctic. In the 1960s, more than 500 blue whales were illegally killed by Soviet whalers near the Seychelles. Until our expedition, no dedicated research had occurred to understand the ecological importance of this region for blue whales. Blue whales typically visit tropical waters to breed and calve, and this area has the potential to be used by migrants from the Antarctic population, as well as a more resident population of "Sri Lankan," or Central Indian Ocean, blue whales.

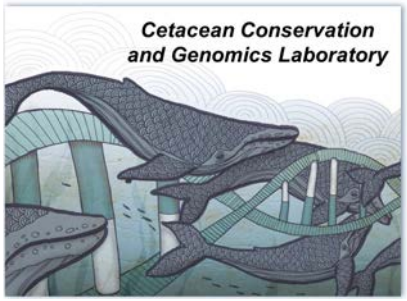
Two years after our expedition, the movie *Blue Whales: Return of the Giants* debuted in IMAX theaters around the country, included the Oregon Museum of Science and Industry on September 22. As part of the film launch, educational modules that focused on some of MMI's research expertise were developed in English and Spanish for children and their families (bluewhalesfilm.com/blue-whale-education-modules).

In addition to the film, the first scientific results from the expedition

Above: Kate Stafford (second from left) with collaborators Jeremy Kiszka, Ella Nancy, and Dillys Pouponeau in the Seychelles.

came out in 2023. Using underwater acoustic monitoring, we discovered that the blue whales we saw in the Seychelles are likely from the Central Indian Ocean population and that they can be heard around the Seychelles for much of the year but particularly during the southern hemisphere summer. This suggests that this may be an important foraging area for this endangered species. ***MMI***

Race Against the Clock



KEITH HERNANDEZ PHD, POSTDOCTORAL SCHOLAR
DEBBIE STEEL, SENIOR FACULTY RESEARCH ASSISTANT

Accurate information on life history parameters is necessary for effective conservation and management, particularly for endangered species. One of these parameters is age. Not only is it useful to know how old an individual is to set context for its behaviors, but also determining the age distribution of a population can aid in management. A population that is skewed toward mostly older individuals will have a different trajectory, compared with a population skewed toward younger individuals.

So how do scientists determine the age of cetaceans? In a few species, we can monitor a coastal population of whales for decades with sufficient resources through identifying unique marks. A great example of such a long-term study is humpback whales in southeastern Alaska. Many of these individuals have known or minium ages from sighting records extending back to the 1970s.

Small samples of skin tissue can now be used to estimate the age of New Zealand Hector's and Maui dolphins using a recently developed "epigenetic clock." Photo courtesy of Oregon State University and University of Auckland.

More often than not, though, the age of an individual whale or dolphin can only be estimated using ear plugs or teeth collected from a carcass. Just like with the rings in a tree, the growth layers in these tissues can be counted to estimate an individual's age. But the requirement for lethal sampling is obviously limited to former whaling operations and simply out of the question for most species.

Molecular approaches to aging have been of interest for decades, but a consistently accurate method has eluded scientists until the recent advances in epigenomics. If we think about the genome of an individual or species as an instruction book for life, epigenetics is the formatting of that book. Epigenetics broadly describes modifications to the genome that alter gene expression but do not change the underlying genetic code. DNA methylation is a chemical modification that occurs naturally throughout the genome and has been shown to correlate with age in organisms ranging from fishes to humans. These methylation measurements can then be applied in mathematical models called "epigenetic clocks" to derive ages.

The Cetacean Conservation and Genomics Laboratory (CCGL), in partnership with the University of California, Los Angeles, the University of Auckland, and the New Zealand Department of Conservation have now developed an epigenetic clock for the critically endangered Māui dolphins and its sister subspecies, the Hector's dolphin.

In a previous newsletter update by Debbie Steel and Scott Baker in 2021, we reported that recent surveys of Māui dolphins found that this population now numbers only 54 individuals. Interestingly, our surveys have suggested that the population might be getting younger, as more recent surveys are finding previously unseen individuals, while individuals seen in past surveys are no longer being seen. Since Māui dolphins generally lack distinctive markings for individual identification, an epigenetic approach to age determination could be an important tool for understanding the dynamics of this population.

We developed a clock using paired samples of teeth and skin collected from beachcast Māui and Hector's dolphins and applied the best-fit model to small biopsy samples collected from living dolphins. Our initial model had a low overall error but showed a poorer fit to age in older individuals. Because we were limited in the sample size of Māui and Hector's dolphins, our solution was to make use of similar data from a different species, an approach that could be of general use for other endangered species. In our case, we used the training data (i.e., skin that had paired teeth samples) from beluga whales from a previous collaboration between the CCGL, UCLA, and NOAA. Since belugas live decades longer than Māui and Hector's dolphins, the resulting model would have better accuracy to predict age in older dolphins. And indeed that's what we found. Using our two best models, we found a shift to a younger overall age in the age distribution of Māui dolphins over the past ten years, confirming the observations from the recent surveys.

So what does this mean for predicting the survival of Māui dolphins? It seems there is good and bad news. The good news is that a shift to a younger overall age of individuals suggests that the population is productive and capable of recovery. The bad news is that the apparent loss of older individuals suggests some source of mortality that is limiting the potential for recovery.

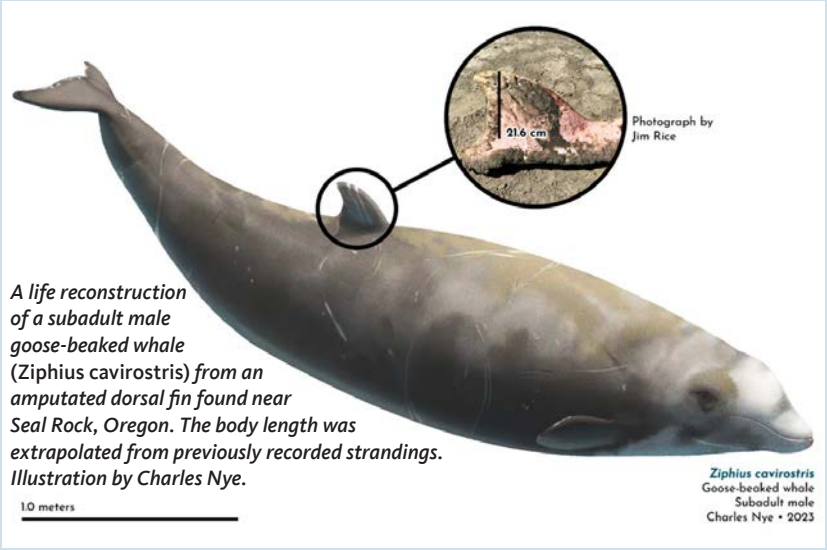
Keith's postdoctoral position has been supported in part by Gray Whale License Plate Funds. We thank Stephen and Lisa Robertson for funding support of genomic resources for this work. ***MMI***

CCGL is Scott Baker, Debbie Steel, Keith Hernandez, Charles Nye, and Kelly Lizewski.

CSI CETACEA: GENETIC IDENTIFICATION FROM BITS AND PIECES

CHARLES NYE

In summer 2022, I had the opportunity to work with the Oregon Marine Mammal Stranding Network under the direction of Jim Rice. Many marine mammals that wash ashore are relatively fresh and recognizable, but others don't fare as well, necessitating a more robust approach to identifying species.



A life reconstruction of a subadult male goose-beaked whale **(Ziphius cavirostris)** ***from an amputated dorsal fin found near Seal Rock, Oregon. The body length was extrapolated from previously recorded strandings. Illustration by Charles Nye.***

Fortunately, short segments of the mitochondrial genome can now be amplified and sequenced to identify most cetacean species. mtDNA is a good candidate for forensic identification because it is abundant in cells of all tissues and can persist for a long time under the right environmental conditions.

Using this molecular marker, we were able to identify several carcasses of interest this summer, including a badly decomposed sperm whale *(Physeter macrocephalus)* on a Florence beach and a killer whale *(Orcinus orca)* entangled in marine debris.

A third case of species identification required a little more "forensic reconstruction." In that case, Jim collected a cetacean dorsal fin (and only the dorsal fin) on a beach near Seal Rock, Oregon. After the lab work, we found a match to mtDNA sequences from goose-beaked whales, *Ziphius cavirostris*. Not only did we identify the species with mtDNA, but also the nuclear DNA was of high enough quality to confirm that it was a male. Only 11 goose-beaked whales have been documented by the Oregon Stranding Network since 1989, and the most recent stranding was 10 years ago. We can only speculate that the dorsal fin was the remnant of a fatal attack by killer whales.

Working with beachcast carcasses of whales and dolphins is not everyone's cup of tea, but I find it fascinating from both a scientific and personal perspective. Each individual has an identity and a story; it is our duty to piece it all together.

This research assistantship was funded by the Oregon Gray Whale License Plate Fund. ***MMI***

Going the Extra Mile

DANIEL PALACIOS PHD, ENDOWED ASSOCIATE PROFESSOR IN WHALE HABITATS

The Whale Habitat, Telemetry, and Ecology Lab was established in 2020 with the three-pronged mission of developing new technology, advancing ecological knowledge, and informing the conservation of whales.

BUILDING A STRONGER TAG

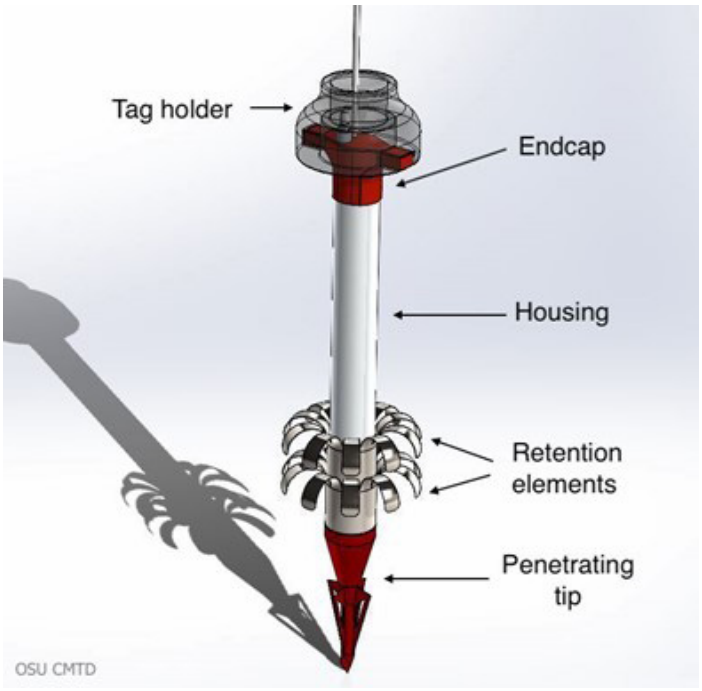
Building on MMI founder Bruce Mate's pioneering development of technology that could track the movements of whales via satellite in the late 1980s, our implantable tags continue to be an important tool for studying whale ecology and for generating knowledge relevant to their conservation today. Through this time, we have worked hand-in-hand with tag manufacturers to continually improve the technology in a variety of ways.

In last year's newsletter, we reported on our latest "smart tag," which is capable of monitoring whale dive and feeding behavior in addition to tracking their movements by satellite over multiple months. That tag remains the state of the art, and this year we embarked on the next evolution of the tag. With funding from the Office of Naval Research, Ladd Irvine and I have set out to redesign the external body ("housing") of the tag to make it more durable. Keeping pace with new developments in materials and manufacturing processes, the new housing will be made of a single piece of stainless steel and will incorporate direct metal laser sintering (a type of 3D printing with metal) to reduce the number of separate components. The new housing will increase the robustness of our tags against breakage, reducing the potential for adverse health effects to the animals, while also delivering improved performance.

Our partners in this project are Marine Ecology and Telemetry Research; Telonics, Inc.; the OSU College of Earth, Ocean, and Atmospheric Sciences' Machine and Technical Development shop; and the OSU College of Engineering's Mechanical, Industrial, and Manufacturing Engineering program.
We anticipate the improved tag will be in production in three years' time.

This project is partially supported by the Joan A. Martin Marine Mammal Fund.

Below: A digital model rendering of our current whale tag, highlighting in red the separate components that will be better integrated with the housing during our tag redesign project.

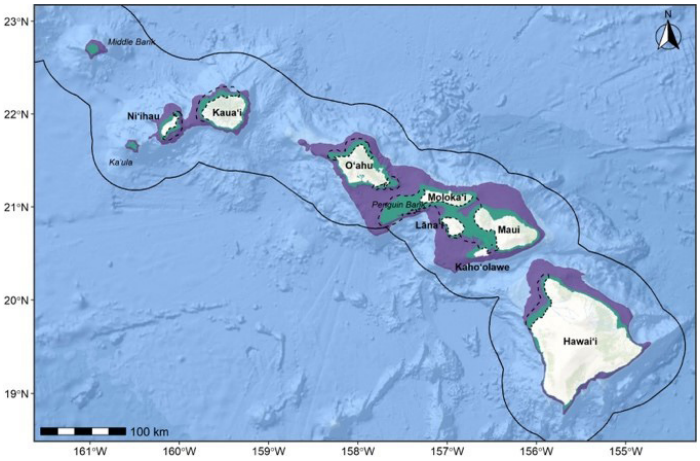


CETACEANS AROUND OCEANIC ARCHIPELAGOS

In 2023, two separate studies published by the lab reviewed the state of knowledge on the distribution and occurrence of cetacean species around two oceanic archipelagos: the Hawaiian Islands, in the central North Pacific, and the Galápagos Islands, in the eastern equatorial Pacific. The Hawaiian study, led by PhD student Michaela Kratofil, was part of a nationwide effort focused on the implementation of a consistent framework for delineating Biologically Important Areas for cetacean species in seven US regions, including the Hawaiian Islands. Biologically Important Areas in Hawai'i were informed by a wealth of existing datasets, including our extensive humpback whale satellite tracking data. This new framework provides an explicit

tool that will be useful in a variety of management applications in the Hawai'i region and other US waters. The study can be accessed at beav.es/TF6.

The Galápagos study, which I co-wrote with Mauricio Cantor, focused on assessing knowledge gaps and identifying priorities for future ecological research around this archipelago. The priorities we identified range from improving basic information in the areas of spatiotemporal occurrence, population status, and health assessments, to tackling more advanced research questions like social and trophic ecology.



Above: The new Biologically Important Areas delineated for humpback whales around Hawai'i, representing the broadly important (purple shapes) and the most important (green shapes) reproductive habitat. Figure from Kratofil et al., 2023.

Compared with Hawai'i and other oceanic archipelagos, logistical and funding challenges have curbed cetacean research in this Ecuadorian archipelago, so our proposed priorities will need to be considered by local and national institutions in broad consultation with stakeholders prior to implementation to ensure that our priorities are relevant, sustainable, and inclusive. The study can be accessed at beav.es/TFu.

The two studies offer contrasting views not only of environmental conditions and the associated cetacean communities around these two oceanic archipelagos but also of different human needs and levels of anthropogenic pressure.

The Galápagos study was supported by the Endowed Professorship in Whale Habitats. ***MMI***

The WHET Lab is Daniel Palacios, Tomas Follett, Ladd Irvine, Michaela Kratofil, Liam Mueller-Brennan, and Ally Kane.

UNDERSTANDING ENDANGERED HUMPBACK WHALES IN MEXICO

DANIEL PALACIOS & JOSH STEWART

In January 2023, Daniel Palacios, Ladd Irvine, Josh Stewart and local collaborators deployed satellite tags on humpback whales in Bahia de Banderas, Mexico. Two subpopulations of humpbacks mingle in this breeding area: threatened Mexican humpbacks and endangered Central American humpbacks. Both populations are impacted by vessel traffic and entanglement in fishing gear throughout their migratory range from Mexico/Central America to feeding areas in the US, Canada, and Alaska.

The movements of these two populations are not well understood, especially in the breeding areas, which has complicated efforts to estimate abundance and risk of interactions with vessels and fishing, especially outside of US waters. In addition, there have been several reports of humpbacks engaging in feeding behavior in and around Bahia de Banderas, which is unusual in breeding areas.

The team deployed 18 satellite tags equipped with sensors to detect feeding events on whales from both populations, providing new insights into movements and foraging behavior in Mexican waters. MMI graduate students Ally Kane and Charlene Pérez Santos will be working on these tag data for their theses research, investigating where foraging behavior occurs and where humpbacks are most at risk from human activities in Mexican and US waters.

Preliminary analyses have revealed extensive apparent feeding behavior by multiple whales along the productive coasts of Mexico, which could represent an important opportunity for these whales to top up on calories before beginning their return migration to summer feeding areas. ***MMI***

Six Degrees of Opportunity

labirinto
Animal Behavioural Interaction Research in the Ocean

MAURICIO CANTOR PHD, ASSISTANT PROFESSOR

As highly mobile social animals, humans connect and disconnect with each other as we transit through our lives. The social and professional networks that emerge along our way give us a sense of purpose and belonging, along with that familiar feeling that it's such a small world out there as if we're only "six degrees" away from each other. This feeling is particularly welcomed when moving to a not-so-familiar location.

We at the Laboratory for Animal Behavioral Interaction Research in the Ocean (LABIRINTO) are a diverse group of newbies to Oregon. In the past year, we've navigated and expanded our own network of collaborations. We've reconnected with old colleagues and reached out to new ones, making our new Oregonian world feel smaller — more connected and purposeful.

Before coming to MMI, I was fortunate to connect with dedicated scientists who painstakingly document the behavior and ecology of marine megafauna. Their hard-earned data and expertise have now become available to our graduate students, opening doors to collaborative research that quick-started our lab and are propelling our students' budding careers forward. Simultaneously, students overseas joined our lab, bringing their own ideas and projects and professional networks that further increased our connectivity.

Here I highlight six opportunities that have arisen from a shared desire of comprehending how marine animals, like humans, rely on social contacts to overcome challenges in life.

HOW THEIR NET WORKS

For decades, our Brazilian colleagues have been studying how dolphins and humans work together for their mutual benefit. We've collected data on artisanal fishers whose interactions with dolphins help to catch migratory mullets. We've watched closely how they cast nets, how many fish they get, and how they team up and become well-known among their peers.

By connecting my Brazilian colleagues from Federal University of Santa Catarina with my German colleagues at Max Planck Institute, it became possible to use high-tech gadgets to track the fishers' fine-scale movements and their beating hearts when cooperating with dolphins. This will allow our new lab member João Valle-Pereira, who will be starting his doctoral research in 2024, to understand how experience and teamwork translate into hunting success in ambush predators (the fishers).

LABIRINTO has expanded its scope to all kinds of human–wildlife interaction — the good, the bad, and the ugly. Above, an example of "the good": cooperative fishing with humans. Photo by Mauricio Cantor.

Far from Brazil, it's the dolphin that makes its own fishing nets. Dolphins in Florida have special feeding tricks —mud-plume and mud-ring feeding. They beat their tails near the sea bottom as if to create a net of suspended substrate to trap the fish. By connecting colleagues from George Mason University, Florida International University, and our own OSU, an opportunity was created for master's student Mahmud Rahman and João Valle-Pereira to work together in revealing how these tactics work and how they shape the dolphins' social lives and risk-taking propensity. With predicted sea level rise, these unique tactics

Above: An example of "the bad": overlap of marine mammal and human activities. Photo courtesy of LEC/UFPR.

Below: an example of "the ugly": a shark entangled in fishing gear results in accidental mortality. Photo courtesy of S. Benjamin.

may be in danger: the shallow habitats where mud-rings are efficient could be gone, so we will develop computer simulations to predict what might happen to these dolphins. With the changing environment, Floridian dolphins may have to cast a wider net and consider less profitable feeding tactics.

In Sarasota, harmful algal bloom events — pumped by pollution and urban runoff — change the quality and availability of dolphin prey. This can push dolphins to risk other ways to catch a bite, such as "begging" handouts from recreational boats or depredating fishing gear. By connecting master's student Kyra Bankhead with researchers from the Sarasota Research Dolphin Program, who have been monitoring these dolphins for more than 50 years, we can quantify how these risky feeding tactics shape the dolphins' social network and how the network in turn shapes the tactics' spreading dynamics. Do dolphins learn to beg or depredate from each other, or do they figure it out themselves? Understanding the underlying social processes will help spread awareness among fishers and prevent spreading maladaptive behavior among dolphins.

UNSAFETY NETS

Humans and marine animals can use the same habitats, which creates conflicting interests between them.Through the work of graduate students from Brazil and South Africa, LABIRINTO now contributes to research projects concerned with how human activities — fishing, boat traffic, urbanization — impact the lives of dolphins, sea turtles, and sharks.

Dr. Shanan Atkins, recently graduated from University of the Witwatersrand, joined LABIRINTO with the mission of helping to resolve human–shark conflicts in South Africa. There, shark nets are set to catch sharks and supposedly protect swimmers, but the gear primarily kills nontarget animals, such as endangered humpback dolphins. By tightening the network of local stakeholders, Shanan is finding alternative ways to make the waters safer for people and sharks.

Gabriel Fonseca, doctoral student at Federal University of Paraná, will join the LABIRINTO to investigate drivers of sea turtle mortality in the western Atlantic Ocean. By developing novel mathematical models, we will predict the places where sea turtles are most at risk due to anthropogenic activities.

Finally, a team of graduate students at Federal Universities of Paraná and Bahia introduced Guiana dolphins to LABIRINTO. Doctoral student Stephane Moura visited LABIRINTO this year, and together with graduate students Daiane Marcondes, Fernanda Fecci, and Tainá Nogueira, they are discovering where and how Guiana dolphins forage, socialize, and communicate. The students are then comparing these activities in conservation units and large port areas to quantify the human impact on the dolphins' lives.

It's indeed such a small world out there, and one that's worth caring for. To this end, professional connections like these are fundamental to LABIRINTO's mission of combining basic and applied research to harmonize animal behavioral ecology and human dimensions. By reconnecting with old colleagues, we took the road most traveled by; by reaching out to new ones, we have followed Robert Frost's advice and also taken the one less traveled by.

"And that has made all the difference." ***MMI***

The LABIRINTO team at MMI is Mauricio Cantor, Taylor Hersh, Kyra Bankhead, and Mahmud Rahman.

Piecing Together an Ocean MOSAIC

BARB LAGERQUIST MS, RESEARCH COORDINATOR

"Can I get some help up here with an ID?" I called over the radio from the crow's nest of the R/V *Pacific Storm*, 25 feet above the main deck, and 46 miles from the northern California coast.

"I'm on my way up," came Lisa Ballance's reply from the science lab radio. "What have you got?"

"I'm not sure," I said, "but it's unlike anything I've seen before."

Then, as if on cue, a 35-foot body burst straight up out of the water beside the vessel. What proceeded over the next half an hour was one of the most remarkable wildlife experiences ever for the people on board.

First, some background.

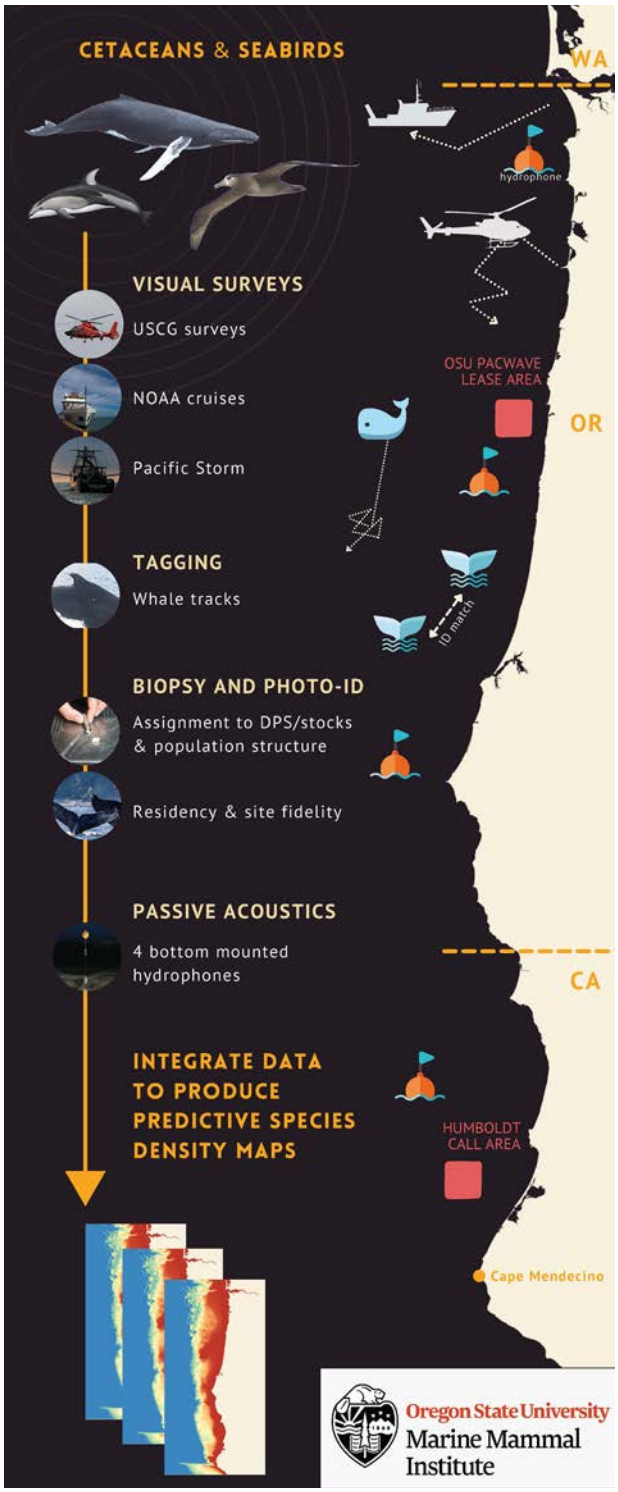
DATA AND MORE DATA

The team of seven MMI and other OSU scientists, including cetacean and seabird specialists, were onboard the *Pacific Storm* in August to conduct a visual survey of the waters of the Northern California Current, between Cape Mendocino in northern California and the Oregon–Washington border. Our mission was to identify and count all the cetaceans and seabirds we saw along a 750-nautical mile (nm) trackline that zig-zagged from nearshore seaward to a depth of 3,000 meters at the outer edge of the continental slope (up to 70 nm from shore).

This survey is part of a project we've dubbed Marine Offshore Species Assessments to Inform Clean Energy, or MOSAIC, to conduct environmental research that will inform the potential development of offshore wind energy along the US Pacific Coast. MOSAIC is one of four projects jointly funded by the Department of Energy and the Bureau of Ocean Energy Management in support of the United States' goal to deploy 30 gigawatts of offshore wind energy by 2030.

MOSAIC consists of two main research components: (1) **visual surveys,** using distance sampling methods for cetaceans and strip transect methods for seabirds, and (2) **passive acoustic monitoring** of cetacean vocalizations, using bottom-mounted hydrophones and echolocation click detectors, to provide complementary data on species occurrence, distribution, and abundance.

Three additional data elements will be strategically added to allow for deeper interpretation: (1) **identification photographs** collected during this project and sighting histories of individual baleen whales, based on



comparisons with previously photographed whales in curated catalogs, to characterize movements and site fidelity at the individual and population level and link humpback whales to distinct population segments; (2) **data from tagged whales,** using recoverable, medium-duration archival tags equipped with high-resolution accelerometers, to characterize site fidelity, behavior, and for blue whales, call rates to better interpret acoustic detections from passive acoustic monitoring; and (3) **DNA profiles of cetaceans,** through mitochondrial haplotype sequencing and nuclear microsatellite genotyping, to provide supporting information on migratory fidelity and individual assignment to distinct population segments.

Data is being collected during the first two years of the four-year project, in all seasons, and consists of six 10-day visual surveys from the *Pacific Storm*, our 84-foot ocean-going research vessel. Two summers of small boat work are led by co-investigator John Calambokidis and his team from Cascadia Research Collective in Olympia, Washington. The project is also leveraged from other ongoing and currently funded MMI research projects (visual surveys from NOAA research vessels and US Coast Guard helicopters, collection of large whale identification photographs, and biopsy sampling) and existing historical data and data products.

The multiple data streams will be integrated using state-of-the-art statistical methods to generate species distribution models capable of predicting species density and distribution throughout the study area. The species distribution models will reveal both spatial and temporal patterns in distribution and abundance for cetaceans and seabirds as well as stock structure and residence patterns for cetaceans.

A WELCOME SIGHT

Back on the vessel, crew and scientists alike screamed with delight as eight Baird's beaked whales swam under and around us, breaching and spy-hopping and fluke-slapping, repeatedly. The whales gave great close-up views of their large bulbous heads, long cylindrical beaks, and two pairs of barnacle-covered teeth erupting from the tip of their lower jaws.

Baird's beaked whales are sometimes called giant bottlenose whales and are the largest members of the beaked whale family, reaching up to 36 feet. They are found throughout the North Pacific Ocean, primarily in cold, deep oceanic waters, where they make long deep dives (routinely to over 3,000 feet, for more than an hour) feeding on a number of open ocean fish species and invertebrates.

For those reasons, sightings at sea are relatively rare. So much so, that of the 11 people on board, only one of them — Lisa Ballance — had actually seen them before. And even Lisa was momentarily mystified by what she was seeing. The whales' acrobatic behavior in such close proximity to the vessel and their school-bus-sized length was startling and thrilling to us all. During the quiet times on watch, when there have been no sightings in what can seem like hours, we talk about what species we want to see. Beaked whales are always high on the wish list. We hope for something rare, for which only a distance glimpse would be special. To have such an unequivocal, remarkable encounter with a new, rarely sighted, species is, indeed, an experience of a lifetime!

A Baird's beaked whale breaches next to the R/V **Pacific Storm** *during the MOSAIC August 2023 survey. Photo credit Craig Hayslip. Photo taken under NMFS ESA/MMPA permit No. 21585.*

The Baird's beaked whales found off the California and Oregon coast are part of the California/Oregon/Washington stock and are believed to number approximately 900 individuals. Beaked whales as a whole are known to be quite sensitive to sound in their environment and the impacts of anthropogenic noise in the ocean is a population concern.

With increasing interest in offshore wind development off the US Pacific Coast, it becomes increasingly important to understand the natural resources found there in order to protect them. The predictive maps generated from the MOSAIC study will provide critical information toward the responsible siting and permitting of offshore wind energy development and for assessing its impacts, not only to Baird's beaked whales but to all cetaceans and seabirds found in Oregon and northern California waters. ***MMI***

For more about this research, visit beav.es/mosaic.

Connections Beneath the Surface

SHEANNA STEINGASS PHD, AFFILIATE FACULTY

Marine mammals are highly visible components of our ocean ecosystems that can shine a light on ocean health. Many environmental issues are magnified in marine mammals, including the presence of pollutants, toxins, and structural changes to marine food webs in rapidly changing oceans.

"Pinnipeds" include seals, sea lions, and walruses and are different from cetaceans in that they spend time on both land and in water. They inhabit coastal shores, meaning there are many interactions between humans and these species in almost every marine ecosystem around the world.

Since 2018, a group of researchers and I have been studying health and ecology of Pacific walrus in partnership with the Alaska Native Communities of Savoonga and Gambell, the Eskimo Walrus Commission, US Fish and Wildlife Service, the North Slope Borough, and other partners. This collaborative work has begun to illuminate emergent issues affecting Arctic pinnipeds and the human communities that have relied upon them as a primary resource for tens of thousands of years.

The annual patterns of sea ice formation and breakup are essential for walrus migration, reproduction, and resting. Walrus also use sea ice as platforms to reach favorite food sources such as bivalves on the sea floor.

When sea ice does not form as expected or melts too quickly, walrus must travel farther to reach preferred foraging grounds or adapt their diet to obtain enough calories. These alternate food sources include fish and sometimes even other marine mammals like seals. Climate-driven ecological shifts could have major implications for this key species.

We examined wild walrus diet using stable isotope analysis and found some walruses were seasonally consuming higher proportions of fish. These same animals were also infected with a fish-specific parasite, *Diphyllobothrium*.

Overall, parasite exposure and even microbiome (gut bacteria) composition of walrus differed based on what the walrus were eating, which has direct implications for animal health. Cumulatively, all these changes spell future conservation challenges for walrus in the warming Arctic.

In addition to affecting how walrus access their food, lack of sea ice also impacts many human communities who have had cancelled or unsuccessful spring and fall hunts in recent years. This represents an alarming risk to native Alaskans who depend on these animals to sustain their families and communities.

Raw walrus meat is an important traditional food source that provides Alaskan communities with key nutrients like vitamin D. Increased exposure to new parasites and pathogens in walrus tissue could pose risks to the human communities who depend upon walrus as an important part of their diet.

Polar wildlife and human communities are disproportionately affected by environmental change, and it is our hope that quantifying, illuminating, and disentangling some of these complex issues can help bring about adaptive management and conservation solutions that will ensure community resilience for walrus and human populations in the Arctic environment. ***MMI***

Founder's Message

BRUCE MATE PHD, PROFESSOR EMERITUS

Greetings to all of our MMI Friends,

Mary Lou and I hope this newsletter finds you happy and healthy. I am so proud of what the Marine Mammal Institute is today, and I hope you share this pride as you read about how your gifts have developed our people, research, teaching, and outreach.

The Marine Mammal Institute of Oregon State University is now a global power in the world of marine mammals. I'm excited about the vision that Director Lisa Ballance has developed to ensure that power continues into the future. We invite you to read about her vision in the inset included with this newsletter.

The founding couple, Bruce and Mary Lou Mate.

We are grateful for your gifts to MMI's success. I hope you are proud of your partnership with us in:

- expanding what we know about marine mammals in Oregon, United States, and international waters to ensure that their habitats remain healthy, from coasts to deep water;
- attracting the best and brightest in our fields and training future generations of professionals (professors, researchers, and conservationists); and
- working internationally to transfer effective tools, technologies, and knowledge to marine mammal practitioners globally.

All of you, our MMI Friends, have been critical partners in our growth and accomplishments. We are especially grateful to former OSU Presidents John Byrne and Ed Ray, John Evey, Stella Coakley, the OSU Foundation, and the Wayne and Gladys Valley Foundation, who, along with many additional endowment seed donors, collectively started MMI and recently built the new Gladys Valley Marine Studies building, which has brought all of MMI together in one amazing place!

The gray whale license plate, which so many Oregonians have on their cars; endowed graduate student fellowships made possible by special families and those of you who have traveled with us to visit gray whales in San Ignacio Lagoon; endowments to support research, faculty, and students; commitments of future gifts through estate plans; and gifts of all shapes and sizes — these have lasting impacts that change the future.

I hope that you see MMI's progress and success as validating your generous gifts to us. MMI's excellent reputation attracts talented students and professionals, and we need your help to further expand so that we can identify and solve emerging marine mammal issues. I believe deeply in Lisa's vision and the legacy your gifts can ensure. What better way to change the world than by securing the future of the animals we love, the oceans they depend upon, and their food webs? Please call me any time to discuss gift ideas to magnify MMI's power. ***~Bruce, (541) 272-1175***

Have you received a thank you note from us? We love our quarterly thank you card writing parties, where we take time to get together with pastries and coffee and and celebrate our MMI Friends!

HELP US BUILD A WHALE

A few years ago, a 70-foot blue whale carcass washed up on an Oregon beach. Recognizing the extraordinary educational opportunity this presented, we went to work to save the skeleton.

The bones of this great animal are now in the hands of experienced professionals for careful repair and reconstruction. Once finished, the skeleton will be on permanent display at the Hatfield Marine Science Center, where it will live on, teaching and inspiring students and visitors to the Oregon Coast.

Help us bring the legacy of this magnifient whale to life. Follow the progress and make a gift at **beav.es/bones**.

BEAV.ES/BONES

Oregon State University
Marine Mammal Institute