Sea Otter Conservation Workshop XIV

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Conference Proceedings

SEATTLE AQUARIUM

Inspiring Conservation of Our Marine Environment

SESSION 1

Management

Moderator: Jim Bodkin

The 2024 southern sea otter census and statistical model development

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The 2024 southern sea otter census included traditional aerial survey methods for the first time since 2019, making the census effort (with accompanying ground count methods) the most complete in the last 5 years. Multiple increasing challenges preventing researchers from achieving 100% survey coverage annually, combined with a recognition that prior traditional census estimates represent running averages of minimum counts, have led to developing a new model-based approach to calculate more meaningful estimates of southern sea otter population size while accounting for temporally and spatially varying survey coverage and detection rates. The rationale, methods, and summaries are presented in this talk.

Washington northern sea otters: minimum population counts and mortality summaries 2023–24

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Northern sea otters (*Enhydra lutris kenyoni*) were extirpated along much of the coast of North America by the early 1900s. During the 1960s and 1970s, otters from Alaska were reintroduced to Oregon, Washington, and British Columbia. In Washington, these efforts were successful, and the population has steadily grown since reintroduction. Aerial and ground-based surveys have been conducted in Washington State since 1989 to monitor the growing population. We will present results of surveys to determine minimum population estimates for 2023 and 2024 and discuss ongoing issues with highly variable counts generated since 2021. In 2023, the aerial survey documented only 1,343 sea otters on the Washington coast, whereas 2,718 otters were counted in 2024. Estimating a population growth rate is challenging given this degree of uncertainty; however, if the minimum count in 2024 is assumed to be an accurate estimate, population growth may be slowing or stabilizing. Efforts to improve these aerial surveys are ongoing. Additionally, a centralized stranding response program for voluntary reports in Washington and Oregon began in 2002. In 2024, the Washington/Oregon Sea Otter Stranding Database was updated and currently WDFW is responsible for the data gathering and entry for all WA/OR stranding data. Between 2023 (n=88) and 2024 (n=102), a total of 190 dead or moribund sea otters were reported. The number of stranded otters were 181 in Washington and 9 in Oregon. The number of dead and stranded reported sea otters continue to increase each year. Causes of mortality and interesting cases will be presented.

British Columbia, Canada sea otter population status update 2024

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The recovery of sea otters in Canadian waters continues to be successful. Given the extensive and expanding geographical range of the British Columbia (BC) sea otter population, our survey effort has shifted from surveying the entire range in one year, as last done in 2017, to

completing the full range over multiple years. Since 2017, we have completed over 50 boat-based surveys from all 24 survey segments representing the range of sea otters in BC as well as areas not yet, or only recently, occupied. These recent surveys and all surveys completed since 1977 are used together to estimate trends in sea otter population growth. We continue to build a dataset of observer estimates of raft size made during boat-based counts and aerial image counts derived from unmanned aerial vehicle (UAV) images collected simultaneously to be able to estimate observer error associated with rafts of varying sizes. Here we present preliminary trends in growth among sub-regions of the range and discuss the status of the population.

Northern sea otter conservation and co-stewardship in Alaska

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The U.S. Fish & Wildlife Service Marine Mammals Management Sea Otter Program (SOP) manages and conserves northern sea otters across Alaska. The SOP works with numerous partners to monitor sea otter population status and trends, Alaska Native Traditional Harvest, facilitate stranding response, and seek wildlife conflict resolution. In recent years, Co-Stewardship has emerged as a tool for sea otter conservation and the restoration of socio-ecological relationships among sea otters, humans, and coastal ecosystems. The SOP has initiated several collaborations with Alaska Native and agency partners to understand the regional complexities facing sea otters and coastal-dwelling peoples, including initiatives to co-design sea otter population assessments. The SOP is also collaborating with social scientists to gather Indigenous Knowledge and local perspectives on human – sea otter ecological interactions and Traditional Harvest practices. In the past six months, the Department of Interior Solicitors Office has undertaken a review of the MMPA and related policy documents in response to Tribal consultations requesting clarity on marine mammal harvest eligibility to help resolve what has been termed 'the Coastal Crisis'; a result of decades of policy ambiguity and an inability to address Alaska Native concerns regarding self-determination of sea otters. The SOP is navigating these high-level policy decisions while continuing to work at the local level to build trust as a foundation for partnership and collaboration. Ultimately, the SOP is entering a new era focused on proactive conservation that strives for equity among Tribes and agencies in effort to conserve our trust species in a changing environment.

Chugach Imaq Initiative

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Since 2020, the Chugach Regional Resources Commission (CRRC) has been working towards a marine mammal harvest and management strategy. With financial support from the NDN Collective, Alaska Center for Climate Assessment and Policy, and Marine Mammal Commission, CRRC created the Chugach Imaq Initiative in 2022. Imaq in Sugt'stun refers to "the ocean, the saltwater, and its contents". Chugach Regional Resources Commission (CRRC) founded the Chugach Imaq Initiative to develop marine mammal harvest management plan that prioritizes the conservation and benefit of sea otter species in the Chugach region. On behalf of the seven Chugach communities, CRRC is working towards revitalizing Tribally-led stewardship of traditional territories and sea otters through co-management relationships with the US Fish and Wildlife Service (USFWS) with a regional focus that centers on Tribal sovereignty. So far, Chugach Imaq has developed Indigenous-led biosampling from subsistence harvests to understand the health and well-being of our sea otter subsistence species, promoted culturally respectful collaborative research, identified gaps in research and monitoring, worked with the Indigenous Sentinels Network to provide app-based research and monitoring support to Tribal communities, and built a collaborative foundation for coproducing science with regional and federal partners through the Chugach Imaq Research Collaborative (CIRC) to support co-stewardship of sea otters and ecosystems in the Chugach region. A founding tenet of CIRC is that direct scientist-to-scientist collaboration among staff within the participating organizations can best establish lasting relationships among Tribes and agencies with a mutual responsibility for stewardship of coastal resources.

Russia and Japan updates

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Here I briefly present the latest survey results conducted in Japan (2017), Kamchatka (2022) and the Commander Island (2019) as reported by Burdin and Volkova (2022). All populations have declined approximately 70% since they were last surveyed in 2007 and 2008.

SESSION 2
Monitoring
Moderator: Jessica Fujii

Comparison of DNA extraction methods for detecting the sea otter (*Enhydra lutris*) in marine sediment

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Environmental DNA holds promise for improving our understanding of historical species occurrence and contemporary biomonitoring. We developed a quantitative PCR (qPCR)-based assay for the sea otter (*Enhydra lutris*) that successfully amplified target DNA from aquaria and from 2/8 seawater samples. We also tested the efficacy of our assay in detecting sea otter DNA from sediment (sedDNA). We compared four sedDNA extraction techniques and two cleaning protocols, using fish and chloroplast DNA as controls. Sea otter DNA was detected at lower rates than expected, despite the confirmed presence of sea otters at the sampled sites. Cleaning protocols reduced sedDNA yield. The present study lays the groundwork for large-scale monitoring of marine mammals using sedDNA and advances the use of sedDNA detection as a valuable tool for reconstructing the temporal and spatial patterns of marine mammal presence. Importantly, this study identifies the need for a better understanding of the effects of marine sediment composition, mammal eDNA shedding rates, and DNA fragment size on detecting target sedDNA.

Quantifying southern sea otter reactions to a quadcopter drone in central California

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The use of unmanned aerial vehicles (drones) is a useful scientific and wildlife management tool as well as a potential source of wildlife disturbance and harassment. Sea otters are a popular subject for photography and videography, and their occupation of marine nearshore habitats makes them accessible to humans operating a variety of craft, including drones. The risk of disturbance to sea otters from drones is high if operators do not adhere to appropriate guidelines; however, current guidelines are provisional and based on anecdotal information. The goal of this study was to provide data to inform science-based guidelines to minimize disturbance when drones are operated around sea otters. Our study was conducted at two sites with consistent groups of sea otters: one with high background anthropogenic disturbance and one with lower background anthropogenic disturbance. Baseline sea otter behaviors were recorded on a scale of 0 (resting) to 6 (full flush) on focal animals for 20 minutes prior to drone launch. Subsequently, three 20-minute flight trials using a DJI Mavic drone were flown over the same focal otter at varying altitudes while observers scored behaviors. At both study locations, sea otters generally had higher behavior scores during drone trials compared to baseline, and these scores increased with descending drone altitude. There was a greater effect of drone presence on sea otter behavior at the site with lower background disturbance, and reaction magnitude was affected by pup presence, gull presence, group size, direction of drone movement (ascending or descending), and flight trial number.

WDFW sea otter conservation planning updates

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Please come meet Jen Mannas, the new Marine Species Lead Biologist in the Diversity Division at WDFW to hear conservation updates for sea otters in Washington. She will give an overview of her division's role in state sea otter conservation and management, an update on the state

Periodic Status Review and Recovery Plan process, and the sea otter's status in the State Wildlife Action Plan.

SESSION 3

Ecology

Moderator: Carter Johnson

Evaluating the influence of a sea otter exclusion ring in the California spiny lobster fishery: implications for California spiny lobster catch and bycatch

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Southern sea otters (*Enhydra lutris nereis*) can become incidentally trapped in shellfish and finfish traps. Based on previous research, modifying the fyke opening (entrance of trap) to include a 5-inch rigid ring can prevent most southern sea otters from entering and becoming entrapped. The California spiny lobster trap fishery overlaps the range of the southern sea otter. Reducing the fyke ring size from the standard 6-to-7-inch diameter flexible opening to a 5-inch diameter, rigid metal ring can reduce or mostly eliminate incidental take of sea otters. However, there is no information on whether this rigid ring would affect the number of spiny lobsters caught, their size, and/or their weight. To investigate this, we used a paired design to fish lobster traps with standard flexible 6-to-7-inch fyke openings (n=15) and traps modified with 5-inch rigid ring fykes (n=15) just before the opening of the commercial spiny lobster fishery season. We analyzed differences between trap types for lobster catch, size and weight using a paired t-test. Results showed traps with the 5-inch exclusion ring caught significantly more lobsters, with no significant change in the size or weight of legal-size (3.25", 83mm) lobsters. This difference appears to be driven by a higher rate of sheep crab bycatch in the standard traps compared to modified traps. These findings suggest the 5-inch exclusion ring may enhance lobster catch rates while preventing sea otters from entering traps, offering a simple, effective mitigation measure to aid in the recovery and population expansion of the southern sea otter.

Reliable estimation of sea otter haul out behavior from time-depth recorders

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Sea otter haul out behavior along California's open coast is cryptic, recorded during less than 1% of all sightings along the Monterey Peninsula from 2004 – 2024. To better estimate the frequency of this behavior, we develop methods to identify haul out events from archival time-depth recorders (TDRs). Specifically, we measure 20 different time, temperature, and diving activity features associated with 30 female sea otters' TDR surface intervals and match with corresponding field observations of typical offshore resting or hauling out. We then perform Bayesian binomial logistic regression simulations to access accuracy of these TDR data to correctly identify either behavior category. Finally, to determine haul out frequency among sample sea otters, we calculate model prediction classifications for all their remaining TDR surface intervals. With an overall prediction accuracy of 90%, the resulting model indicates that haulout behavior is 10-fold more prevalent than detected by visual observations but highly variable by individual sea otter. Also, relative to typical resting behavior, hauling out occurs more frequently during lower tides, overnight and early morning hours, winter through early summer months, and longer intervals.

A low-cost, open-source framework for standardized ROV photo surveys within kelp forests

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A central goal of sea otter conservation is the preservation or restoration of the ecological functioning sea otters provide along coastal ecosystems. Challenging the evaluation of this functioning however is our limited ability to survey benthic community structure. ROVs have the potential to expand the spatial extent across which we collect data and make inferences in kelp forests, but thus far ROVs have yet to be systematically integrated into long-term kelp forest monitoring programs. This talk will provide an update on a suite of Seattle Aquarium research projects that have implemented ROV-based benthic surveys. Topics will include our 1:1 methods comparison between diver- and ROV-derived data, custom software enabling semi-autonomous

ROV flight operations, updated lighting and imaging methods that have improved image quality, and revised AI methods of image analysis that have expedited algorithm training. Our ongoing grant-funded projects are presently focused throughout Puget Sound, though in 2025 we will expand and co-create a project alongside Makah Fisheries Management in order to evaluate the impact of sea otters upon benthic community structure offshore of Neah Bay.

Keystone interdependence: sea star loss in the rocky intertidal leads to mussel expansion and sea otter population responses

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The sea star *Pisaster ochraceus* and sea otters (*Enhydra lutris*) are two predators capable of shaping rocky intertidal and kelp forest community structure and functioning through strong cascading effects. In 2013, a catastrophic sea star wasting event decimated Pisaster populations along the west coast of North America. The collapse of this species in the rocky intertidal revealed an unexpected relationship between two keystone predators. In this study, we show how the loss of Pisaster along the Monterey Peninsula, California, USA led to an increase in mussel (*Mytilus californianus*) cover and expansion into the lower rocky intertidal zone. Prior to the sea star wasting event, invertebrate prey-limitation in central California kelp forests contributed to sea otters reaching a near equilibrium with slow population growth. However, in the absence of Pisaster owing to the sea star wasting event, sea otters increased their dietary intake on mussels, which contributed in-part to a local population-level rise. These results demonstrate how the loss of a keystone predator in one ecosystem may impart changes in another through multiple indirect effects. Therefore, we infer that cross-ecosystem coupling can occur through keystone interdependence.

Forecasting sea otter recolonization: insights from isotopic analysis of modern and zooarchaeological populations

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Retrospective datasets offer essential context for conservation by revealing species' ecological roles before industrial-era human impacts. We analyzed isotopic compositions of pre-industrial and modern sea otters (*Enhydra lutris*) to reconstruct pre-extirpation ecology and offer insights for management. Our study focuses on southeast Alaska (SEAK), where sea otters are recolonizing, and northern Oregon, where

translocations are being considered. We measured bulk bone collagen δ13C and δ15N values, and essential amino acid δ13C values of extirpated sea otters from archaeological contexts, and bulk isotopic values from vibrissae of modern SEAK sea otters. We compare these results with published isotopic data of potential prey and additional archaeological datasets. In SEAK, our data show pre-industrial sea otter populations consumed infaunal bivalves and used soft-sediment (33%) and kelp forest habitats (67%), with sub-regional variation. In northern Oregon, isotopic data from extirpated sea otters indicate past consumption of low trophic level invertebrates and a stronger reliance on kelp forests (88%) rather than soft-sediment habitats, highlighting the importance of kelp forests for future translocations. Our work exemplifies the value of historical ecology in informing conservation strategies for recovering species.

Ways of knowing sea otter and abalone dynamics in Alaska communities

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In Southeast Alaska, re-established Northern sea otter (*Enhydra lutris kenyoni*) populations have cascading effects on ecosystems, communities, and marine resources. While regional-scale studies provide valuable insights into patterns of these effects, the impacts of otter establishment at more local scales are less predictable. Intermittently monitored sea otter populations expand into sub-regional areas with different and, at times, undocumented histories of commercial, subsistence, traditional, and customary harvest of otter prey items like pinto abalone (*Haliotis kamtschatkana*). Limited area-specific information on harvested pinto abalone populations and infrequent records of local otter occupation, abundance, movement, and hunting patterns constrain Western scientific attempts to untangle interactions between community subsistence and target species at the local scales most relevant to harvesters. The "Ways of Knowing Sea Otters and Abalone" project, developed with the support of the local Sitka Tribe of Alaska, couples available quantitative data on abalone and otters with information from local individuals, including those with a history of commercial or subsistence abalone harvest and from Alaska Natives, with expertise on local harvest and sea otter hunting practices. Knowledge shared during interviews and mapping exercises paired with quantitative survey data provided a higher resolution understanding of dynamic local trends following abalone harvest, sea otter occupation, hunting, and population movement than previously available. This inclusive research approach advances the collective knowledge of local, harvested populations and supports tribal and stakeholder sovereignty in the management and future research of these important species. Finally, this work reinforces the power of information amassed through

multiple knowledge systems to offer more comprehensive and nuanced perspectives on sea otter hunting, abalone harvest, and more intricate trends following local sea otter return.

SESSION 4

Sea Otter Conservation Volume II

Moderator: Erin Foster

Chapter 1: Introduction to Sea Otter Conservation Volume 2

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The theme of Sea Otter Conservation Volume II is the exploration of continuing restoration of nearshore marine habitats, food webs, and ecosystems throughout the North Pacific, achieved through sea otter conservation and re-occupancy of historical habitat. This theme is informed by what scientists have learned in the 20th and 21st centuries about sea otter biology and their role in nearshore ecosystems after near extirpation and subsequent recovery following the maritime fur trade of the 18th and 19th centuries. Volume I of Sea Otter Conservation focused on species specific biology, as well as on the history of sea otters and their relationship to humans. In this Volume II, the authors summarize current understanding of sea otters and their role in the nearshore marine environment in two complimentary sections. Section 1 chapters explore the direct and indirect role that sea otters play in the structure and function of nearshore ecosystems and how the absence and presence of sea otters facilitated studies. It includes chapters on: The effects of sea otters in rocky reef communities; in seagrass and estuarine communities; and in unconsolidated sediment communities; linkages between the ocean, nearshore, and terrestrial ecosystems mediated by sea otters; and how the fur trade created an "experiment" that facilitated both ecological and biological study and modified human perspectives and relations with sea otters. Section 2 chapters explore the process of sea otter recovery following the fur trade, how abundant resources affected recovery, and the potential for sea otters to further facilitate ecosystem restoration. It includes chapters on: the history of monitoring sea otter recovery and conservation; the role of space, behavior, and movements in sea otter recovery; what drives sea otter population growth; the application of molecular methods to understand sea otter history and recovery; the potential to restore nearshore

ecosystems through future sea otter reintroductions; and a summary of the books content with a look toward the future.

Chapter 3: The role of sea otters in seagrass and salt marsh communities

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Sea otters are known for structuring rocky-reef communities and stabilizing kelp forest communities, yet their influence in seagrass and salt marsh communities is less clearly understood. In this chapter, we discuss what is known about how sea otters alter vegetated soft sediment communities, including eelgrass (*Zostera marina*), and salt marsh communities composed primarily of the foundation species pickleweed (*Salicornia pacifica*). Across their range, sea otter recovery is correlated with increased eelgrass biomass. In California, sea otters increase eelgrass biomass through a trophic cascade: by limiting crab predation, sea otters indirectly increase mesograzer abundance, which limit epiphytes and increase eelgrass biomass. In the northern part of the sea otters' range, the mechanism behind the positive correlation between sea otters and eelgrass may be driven by the removal of clams, which relieves space competition and may reduce anoxia. Sea otter digging for infaunal prey is thought to influence the reproductive strategies of eelgrass and is positively correlated with eelgrass genetic diversity where sea otter populations are established. In salt marshes, sea otters limit shore crabs and their burrowing, thereby stabilizing tidal creek shorelines and salt marsh vegetation. Sea otters hauling out on salt marsh vegetation has been observed to increase Salicornia biomass, perhaps through deposition of urine and feces, which function as fertilizer. The maritime fur trade greatly reduced sea otter populations, disrupting ecological relationships in nearshore systems. Through this historical lens, Chapter 3 considers the effects of sea otters. Given the rich history of sea otter, eelgrass, and salt marsh coevolution, sea otter recovery may confer ecological resilience and stability in seagrass and salt marsh systems.

Chapter 4: Sea otters in mixed sediment habitats

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Sea otters occupy a range of unconsolidated substrates, characterized by varying proportions of fine- to coarse-grained sediments, known as mixed sediment habitats. This chapter examines the importance of protected and semiprotected mixed sediment habitats to sea otters, some of which can support diverse algal and seagrass communities. The importance of mixed sediment habitats in sea otter conservation has largely been underappreciated, yet mixed sediment habitats have proven essential to the recovery of sea otter populations across their range, supporting some of the highest densities of sea otters along the Pacific Rim. We examined sea otter diets through time, across the range of habitats that otters occupy, and found that clams make up an average of 44% occurrence. Given the requirement of clams to burrow in sediments, clams as a mainstay in sea otter diets highlight the importance of mixed sediment habitats. We also discuss the importance of protected and semiprotected mixed sediment habitats to sea otter conservation in terms of shelter and predation risk. We examine confirmed and hypothesized pathways through which sea otters may structure and influence mixed sediment communities. We consider ideas about how size selective predation by sea otters may have affected clam adaptation through plasticity in size-at-first reproduction and population turnover rates and consider how sea otters, people, and intertidal clams might have coexisted in the past, supported by Indigenous mariculture. Throughout, we discuss the role of the maritime fur trade in shaping our perspectives of the importance of mixed sediment habitats to sea otter conservation and ecosystem restoration.

Chapter 6: A catastrophic and unintended experiment: revising our understanding of sea otters and their social and ecological importance based on a system in transition

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Sea otters have occurred in coastal ecosystems of the North Pacific for about a million years, and since the end of the last glacial period (between 5 and 10 thousand years ago), they have overlapped with and apparently coexisted with human societies over much of their geographic distribution in North America. This period of sea otter/human coexistence ended abruptly, about 270 years ago, with the initiation of the commercial fur trade in the North Pacific. Between 1741 and 1911, sea otter populations were serially depleted until they were all but extinct, with only a

dozen or so tiny populations remaining, mostly in remote areas of southwest Alaska. One way to view the extinction of sea otters over this vast area is as a giant removal experiment: by measuring responses of other species to this perturbation one could, in principle at least, elucidate the effects of sea otters on ecosystem structure and function. The piecemeal recovery of sea otter populations over the last century can be viewed as a second experiment, with replicated treatments (and controls) scattered from the Bering Sea to southern California. And indeed, this "experimental perturbation" lens has provided the conceptual framework for much of the research on sea otters and their ecology. We use this lens to examine the wide range of insights that have been gained by taking advantage of the experimental perturbation represented by the removal of sea otters, as well as the secondary perturbation associated with their recovery and return to coastal ecosystems from which they had been absent for over 100 years. For each perturbation, we highlight key ecological and socio-ecological relationships that were lost, and in some cases recovered, and important insights that have been gained by carefully observing the dynamic nature of responses to these perturbations. We focus on subject areas for which the experimental approach has been particularly informative, including community ecology, population biology, behavioral ecology, genetics, and socio-ecology. Much of the research we summarize has broadened and expanded upon the pioneering work conducted by Jim Estes and colleagues, who first recognized the potential power of leveraging the fur trade-induced depletion (and then recovery) of sea otters as a grand experiment. There have also been surprises, as emerging patterns and new discoveries have challenged some of our most basic assumptions about sea otter ecology. We discuss the intellectual and social hazards inherent in failing to recognize that patterns we find in nature are often ongoing responses to a massive socioecological perturbation. Finally, we look forward to some exciting areas of research that are emerging in the final stages of the fur trade experiment research that focuses on important but often under-appreciated relationships that were lost and that will take time, effort, and diverse perspectives to fully restore.

Chapter 9: What drives sea otter population growth and recovery: a large-scale perspective

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In this study of sea otter population recovery, we analyzed abundance, foraging activity, health, and stress at 12 sites distributed among demographically distinct regions spanning their range in North America. Sites were categorized as either "core" or "periphery" based on their location and duration of occupancy. We developed models based on information from long-term population surveys and short-term foraging and health surveys to explore their relationship to population status at each site. Among 11 sites with a recovering population, long-term population growth rates from 1986 to 2016 averaged 3.2%/yr at core sites and 9.0%/yr at periphery sites. Energy intake rates collected from 2010 to 2012 differed significantly, with periphery sites having a higher average median intake rate of 15.7 kcal/min compared to core sites at 8.2 kcal/min. Population growth rates were positively correlated with energy intake rates ($r = 0.73$), consistent with density-dependent processes for recovering sea otter populations. We then explored the robustness of our models by including a test case of a remnant core site with a strong density-independent influence due to killer whale predation, which led to a weaker correlation between foraging rates and population growth. Individual sea otter health also varied by site status, with poorer dental conditions for males at periphery sites and for females at core sites, and larger body mass (adjusted by age, sex, and subspecies) for both sexes at periphery sites. Foraging and population growth rate patterns and health evaluations were consistent with density-dependent processes.

Chapter 10: Insights from molecular methods into past and present sea otter populations

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In recent decades, the use of molecular methods to understand sea otter genetics and ecology has accelerated, providing new insights into sea otter populations, both past and present. Genetic and stable isotope analyses have contributed to an increased body of knowledge about population genetics and dietary ecology by analyzing sea otter samples from before, during, and after the maritime fur trade. The combination of new methods and increased sampling from a wide temporal and geographic range have important implications for understanding the sea otter's past, which may help inform the eventual recovery of sea otters throughout their range. This chapter outlines (1) methods used in sea otter molecular studies and their respective advantages and limitations, (2) new insights from molecular studies into sea otter population genetics and historical and present food web dynamics, and (3) an argument for continued analyses of archaeological and historical samples. This review focuses on studies from 2009 to 2023 for stable isotopes and 2012 to 2023 for genetics. Future directions include increased sampling of sea otters from still-understudied geographic regions, including Russia and Japan, and utilizing emerging techniques such as environmental DNA, multiomics, and compound-specific stable isotope analysis to gain additional insights into past sea otter populations, their ecological history, and their role in coastal ecosystems over time.

Keynote

Jane Bacchieri, Elakha Alliance

The Elakha Alliance: building on partnerships to restore sea otters to Oregon

SESSION 5

Husbandry

Moderator: Amy Olsen

Monterey Bay Aquarium rehab and surrogacy update

Jessica Fujii, *Monterey Bay Aquarium,* jfujii@mbayaq.org

The Monterey Bay Aquarium continues to be a leader in California live sea otter stranding response and has been working closely internally and with external partners to expand our capacity to rehabilitate and release sea otters each year, and support placement of non-releasable sea otters to other zoos and aquariums. Notably, our expansion of sea otter surrogacy with Aquarium of the Pacific officially began in 2024 with resounding success, and in March 2025 construction of two new tanks and ICU units were completed at the Monterey Bay Aquarium for rehabilitation purposes. A summary to recent cases and future outlook will be presented.

Flying six very furry friends a far, far way: innovating a Sea Otter Transport Unit (SOTU) to mitigate challenges faced during long distance transport

Brian Rokeach, *Sea World Yas Island Abu Dhabi,* brokeach@miral.ae
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Sea otters (*E. lutris*) are a challenging and difficult species to transport between zoological facilities. This is related to both the otters behavioral and physiological needs. Elevated metabolisms require regular nourishment and behaviorally the otters need almost constant opportunity to groom their thick fur. Both ecological needs are promoted with the animal's ability to be submersed in water. These three factors challenge the ability to reliably transport sea otters over long distances. SeaWorld Yas Island Abu Dhabi was asked to move 3.3.0 sub-adult Northern sea otters from San Diego to Abu Dhabi, UAE, a transport of over 8000 miles with a timeline exceeding 24 hours. The SeaWorld team developed a sea otter transport unit

(SOTU) that would provide both behavioral and physiological needs so the animals could comfortably travel the extended distance. Each SOTU could accept two sea otters with the ability to fill and empty a pool within the SOTU and allow the otters to spend the majority of the flight immersed in water, a key welfare factor. An extensive behavioral plan was developed so all six otters would be familiar and comfortable with their SOTUs well before partaking on the long transport to Abu Dhabi. The transport was successful in early 2023 and the otters arrived comfortably and in good condition after a 36 hours of transport. All six otters are currently thriving at their Arctic habitat and have been sharing with our Gulf region guests their amazing importance as a keystone species in important sub-Arctic ecosystems.

Sea World San Diego otter program and transport updates

John Stewart, *Sea World San Diego,* John.Stewart@SeaWorld.com

In 2021 Sea World San Diego developed several key goals for our Southern Sea Otter program. In addition to training philosophies and training goals, the means with which we transport our otters was a big focus. Goal #1: Support the two facilities currently facilitating otter surrogacy programs by providing age-appropriate females as needed and taking in non-releasable pups. Goal #2: Develop an alternative method for transporting otters to and from other facilities.

Assessing short-term effects of internal tag implantation in sea otters

Ana Velasquez, *University of Alaska Anchorage,* alvelasquez@alaska.edu

Research on sea otter (*Enhydra lutris*) populations is often conducted from shore using direct observations; this methodology has many advantages but is time-consuming, requires trained observers, and can be biased due to environmental factors. Due to these challenges, telemetric or archival tagging devices have been used to understand sea otter ecology, behavior and vital rates. Although best practices have been followed, no assessment of implant procedure effects on sea otter individuals have been published. This study aims to determine short-term effects of surgical tag implantation using historical data from tags deployed in Northern sea otters. Temperature data from Time Depth Recorders (TDR) and Life History Transmitter (LHX) tags were analyzed to identify whether implantation was associated with fever, a sign of infection post-surgery. Preliminary results suggest that TDR tagged sea otters (n=19) experienced elevated body temperatures directly following implantation but were able to recover to their normal temperature within the expected healthy temperature range 36-38°C. This elevation in body temp is likely the result of systemic inflammation associated with wound healing. Next steps will investigate changes in behavior from TDR dive data during a three-month window

post-surgery and pair activity with body temperature fluctuations. The preliminary results presented will begin to provide a timeline of recovery post-tagging which will support future internal tag research and the analysis of existing datasets. Results will work to inform researchers and managers of potential risks to sea otter individuals or effects on research inferences resulting from instrument implantation.

AZA sea otter program and studbook updates

Julie Carpenter, *Independent,* millerj222@hotmail.com
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AZA Sea Otter Program and Studbook Updates.

Voluntary blood sample collection from the hind leg digital veins

Matt O'Connor, *Georgia Aquarium,* moconnor@georgiaaquarium.org

Voluntary blood sample collection training is a useful medical behavior to monitor health in managed care sea otters. Many locations have been attempted for voluntary phlebotomies including cephalic, popliteal and lateral tail vein. Each location has a different set of challenges and risks. The digital vessels in the hind legs were investigated during anesthetized routine exams and were successfully used for catheterization and blood collection. This brief talk will share our recent experiences developing the set up and training the hind leg digital vessel location for successful voluntary blood sample collection on a male Southern sea otter (*Enhydra lutris nereis*).

Leptospirosis in southern sea otters (*Enhydra lutris nereis*)

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Leptospirosis periodically causes disease outbreaks in California sea lions (CSL) in central and northern California. However, leptospirosis only occurs sporadically in sympatric phocids but had not been reported in southern sea otters (SSOs). As sentinels of estuarine and coastal health, the goal of this study is to characterize the serologic, molecular, and pathological features of leptospirosis in this key species. A retrospective search of cases with renal or hepatic gross and/or histologic pathology suggestive of leptospirosis was performed. Seventeen cases were selected based on lesions and archived samples. By contrast with CSLs, affected SSO kidneys were generally unremarkable on gross examination. On histology, 4 of 16 cases had significant lymphoplasmacytic tubulointerstitial nephritis and acute tubular necrosis consistent with leptospirosis, while two cases had non-specific tubulointerstitial nephritis that could be attributed to leptospirosis, septicemia, or ascending bacterial infection, and one case had chronic sequelae to a previous infarction. Two cases had bile nephropathy due to microcystin toxicosis, and four had incidental non-specific mild interstitial nephritis, while three had few to no changes or suspected age-related mild glomerulopathies. Immunohistochemistry (IHC) for leptospiral antigen was positive for the four suspect cases. Livers had incidental lymphoplasmacytic and neutrophilic portal hepatitis (6), random hepatitis suggestive of septicemia (3), and centrilobular necrosis consistent with microcystin toxicosis (6). Leptospiral IHC was negative for all liver sections. PCR was positive for pathogenic *Leptospira* spp. on 12 of 17 kidneys. Microagglutination serology for various *Leptospira* serovars on 12 SSOs showed that the four suspect cases, with renal histopathology and positive IHC, had strong titers against *L. interrogans* serovar Pomona, the serovar commonly detected in CSLs, three others were weakly positive against *L. interrogans* serovar Icterohemorrhagiae, and one was weakly positive against *L. interrogans* serovar Hardjo. The possibility of cross reactivity in these four cases cannot be discounted. In conclusion, leptospirosis should be considered a cause of renal failure and death in SSOs. PCR results also suggest that SSOs, like CSLs, can be asymptomatic carriers of *Leptospira spp.* Both hosts are affected by *L. interrogans* serovar Pomona suggesting that further investigation is needed to understand the disease transmission and ecology of leptospirosis between sympatric hosts.

Acknowledgements: The work was conducted under relevant permits and funded by U.S. National Fish and Wildlife Service - John H. Prescott Marine Mammal Rescue Assistance Grant Program (F23AP02422). Dr R. Stoddard, CDC, Atlanta, contributed to this study.

SESSION 6

Reintroductions

Moderator: Jane Bacchieri

Revisiting Oregon's 1970s translocations

Robert Bailey, *Elakha Alliance,* bob@elakhaalliance.org

The translocations of 93 sea otters from Amchitka Island to the southern Oregon coast in 1970 and 1971 resulted in population failure by 1981. This failure has raised many questions about why it did not succeed, about the animal handling techniques used, whether the Oregon coast had sufficient sea otter habitat, and whether animals from the Aleutian Islands were genetically "fit" to survive in Oregon. A close examination of the translocation and its aftermath answers some of these questions. This talk will examine the region into which the animals were released, the methods of capture, transport, and release, and the initial survival and distribution of the population over ten years at habitat sites across a broad region. Current population modeling also provides additional insights into possible explanations of population decline and failure. Together, this review offers lessons for future translocations to Oregon.

A path to southern sea otter recovery: toward the implementation of the conceptual framework

Andrew Johnson, *Defenders of Wildlife,* ajohnson@defenders.org

Over the past two years, Defenders of Wildlife (Defenders), with the support of two grants from the California State Coastal Conservancy's Sea Otter Recovery Fund, has helped coordinate stakeholders and tribes in discussions about the potential reintroduction of sea otters to northern California and Oregon. Facilitated meetings and additional project teamwork throughout 2023 and early 2024 culminated in a July 2024 report, "A Conceptual Framework for Southern Sea Otter Reintroduction." The document provided suggestions and recommendations for the ongoing pursuit of a southern sea otter reintroduction program. A second grant project

is focused on the next steps in reintroduction planning through approximately June 2025. This project includes the following tasks:

- •Restructuring partner groups to better address the sea otter reintroduction framework and advancing the case for broader coastal restoration and rewilding.
- •Strengthening connections to coastal tribal entities and encouraging tribal leadership in the sea otter reintroduction process.
- •Identifying and engaging with coastal communities that might experience impacts from a sea otter reintroduction.
- •Undertaking preliminary socioeconomic evaluations of a potential southern sea otter reintroduction.

This work dovetails with and relies upon parallel efforts by partners to model a sea otter reintroduction program, revise the recovery plan for southern sea otters, expand the sea otter surrogacy program, and identify funding sources. The presentation will highlight aspects of the reintroduction planning framework and will tee up talks by other presenters.

Building bridges: engaging Oregon's fishing communities in sea otter reintroduction

Kyle Motley, *Elakha Alliance,* kyle@elakhaalliance.org

The reintroduction of sea otters to the Oregon Coast represents a unique opportunity to restore ecological balance and enhance coastal resilience. However, the success of such an endeavor depends on fostering mutual understanding and collaboration with stakeholders, particularly within Oregon's fishing industry. The Elakha Alliance has undertaken a proactive outreach program to engage fishers, aquaculture businesses, recreational users, and other coastal stakeholders in meaningful dialogue about sea otter reintroduction. This presentation will highlight the Elakha Alliance's strategies for building relationships and addressing concerns related to resource competition, ecosystem changes, and economic impacts. Through one-on-one meetings and proposed stakeholder workshops, Elakha is working to provide accurate scientific information about sea otters' ecological roles, facilitate discussions about stakeholder concerns, and share information on potential reintroduction scenarios. Additionally, this presentation will seek feedback and advice from the audience about our approach and potential opportunities and strategies that might also be considered. By centering the voices of fishing industry stakeholders, the Elakha Alliance aims to share up-to-date information and build relationships to achieve conservation success through inclusive and transparent stakeholder engagement.

Updating the California-Oregon sea otter recovery model

Jessica Fujii, *Monterey Bay Aquarium,* jfujii@mbayaq.org
M. Tim Tinker, *Nhydra consulting and University of California Santa Cruz,* ttinker@nhydra.com

Updates to the integrated population model referred to as California-Oregon Sea Otter Recovery Simulations (COSORS) have been underway to help inform management strategies. Here we will review the model methods and applications.

SESSION 7

Conservation/Advocacy

Moderator: Andrew Johnson

Diversity Equity Inclusion and Justice update

Amy Olsen, *Seattle Aquarium,* a.olsen@seattleaquarium.org

The Seattle Aquarium views diversity as a strength, and we recognize our responsibility to include the skills and varied perspectives of all people. As we strive to create a welcoming space at the Sea Otter Conservation Workshop, we need baseline data to track and gauge changes in the community over time. Here, we will share general results from our 2025 demographics survey, as well as cover commitments made by the Seattle Aquarium and the creation of a guide to conduct conservation research with an anti-racist lens.

Illuminating relationships in the nearshore

Ken Collins, *USGS,* kcollins@USGS.gov

Complex ecological systems, such as the nearshore, exhibit a multitude of behaviors and responses and have many inter-related components. Many of us try to understand these systems. Adding to the study system's natural complexity is the complexity of the act of research itself. The relationships that scientists must process include those not just between organisms, but between people, projects, and knowledge. This task is especially challenging as older

generations of pioneers with valuable institutional knowledge retire and are replaced by younger generations of scientists. We have started developing and experimenting with an interactive tool that models limitless aspects of the nearshore. By illuminating and organizing things (e.g. people, species, projects, publications) in the nearshore according to the relationships between them we aim to connect the knowledge base of the nearshore research community and improve the productivity and efficiency of researchers, managers, and stakeholders. Over time, we hope this tool can serve as a platform to respond to questions at the ecosystem level. This session will cover context, approach, and early results, including a demonstration of the tool, Nearshore Web, from the perspective of sea otters.

Surfers and sea otters: exploring a unique relationship

Dakota Peebler, *Heirs To Our ocean,* dakota@h2oo.org

Research by Sea Otter Savvy has established that sea otters are under threat of human disturbance. Marine recreationists like kayakers and paddleboarders, wanting to get a better look or photo of this classic California animal, knowingly or unknowingly approach sea otters too closely, disturbing the delicate balance of behaviors sea otters must maintain to survive. Is this true of all types of marine recreationists? Surfers–in the ocean in pursuit of a sport–may have a different relationship with the sea otters inhabiting their surfing spots. This last summer, Dakota Peebler, a co-founder of Heirs To Our Ocean in partnership with Sea Otter Savvy, investigated the frequency, nature, and outcomes of surfer-sea otter interactions at two surfing hotspots in Santa Cruz. Through in-the-field sea otter monitoring and personal recollections from surfers regarding their experiences with these keystone species, Dakota shares what she has learned at the culmination of this summer research project.

Sea otter, *Enhydra lutris*, conservation legacy and potential for recovery, the IUCN green status

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Sea otters, *Enhydra lutris*, are marine mammals found throughout north Pacific nearshore areas, from Northern Japan in the west Pacific to Baja California in the east Pacific. Sea otters were nearly hunted to extinction by the international maritime fur trade from 1741-1910. To date, they have recovered to almost half their pre-exploitation numbers, yet they remain absent or

depleted in many areas of their historic range. Sea otters are keystone species stabilizing and recovering nearshore ecosystems in many areas after recovery from the fur trade. Their effect is particularly notable in kelp forest, sea grass and salt marsh systems where they exert top-down control by eating benthic invertebrate grazers. They are listed as Endangered on the IUCN Red List of Threatened Species due to declining populations in the western portion of their range linked to orca (*Orcinas orca*) predation and range stagnation in the southern part of their range linked to great white shark (*Carcharodon carcharias*) predation. The IUCN Red List is an assessment of a species' extinction risk. Newly complementary to the Red List is the IUCN Green Status Assessment, which is an assessment of the effect conservation efforts past, present and future may have in species recovery. The Green Status for sea otters was recently completed and based on efforts after the fur trade and others to recover sea otters throughout their range such as reintroductions and reducing the potential risks of oil spills in nearshore areas, sea otters are considered still largely depleted. Sea otters have a high conservation legacy and high potential for further recovery. Here I will walk through how we came to this assessment and what future conservation efforts could do for sea otters range wide.

Sea otter recovery and community engagement: a look into public perception of reintroduction

Heather Barrett, *Sea Otter Savvy,* heather.e.barrett09@gmail.com

The "We Were Here" sea otter recovery survey opened in September of 2020 during Sea Otter Awareness Week and continues to collect public comments and input regarding potential reintroduction into the northern CA and OR. A report of the last 4 years of results is in process, in collaboration between Sea Otter Savvy and the San Diego Zoo Wildlife Alliance. Results will highlight current public perception and specific stakeholder opinions regarding potential reintroduction and clarify future engagement opportunities.

Community active wildlife stewards: engaging California central coast businesses in sea otter conservation

Gena Bentall, *Sea otter savvy,* gena@seaottersavvy.org

Community Active Wildlife Stewards (CAWS) is a wildlife stewardship certification program organized by the nonprofit research and outreach organization, Sea Otter Savvy. The goal is to develop a community-based education and recognition program for California central coast businesses and organizations to increase their awareness and knowledge about responsible marine wildlife viewing practices and, ultimately, reduce human disturbance to sea otters and other marine wildlife. Businesses apply for CAWS certification and then complete a review

process that includes evaluation of their business practices relative to a written standard of wildlife stewardship. Review components include advertising, customer orientation, staff training, and both customer and undercover shopper surveys. If applicants meet the review requirements, they are awarded certification. Since launching in 2019, CAWS has certified ten businesses, including five kayak/SUP rental and tour operators, three boat-based tours, and two wildlife photographers. In 2023, 100% of CAWS participants polled (n = 8) agreed or strongly agreed that CAWS has changed the way they operate their business and 87.5% rated their experience with CAWS as excellent. To gauge effectiveness and reach, we conduct quarterly surveys of California residents who engage in marine recreation on the central CA coast. In 2024, 51% of respondents (n = 101) knew about CAWS with 45% of those claiming that CAWS influenced their choice of which kayak rental business to patronize. CAWS provides model for other communities seeking a positive, partnership-focused platform for engaging businesses in wildlife stewardship.

Advancing sea otter recovery: introducing the Sea Otter Fund

Charles Knowles, *Wildlife Conservation Network*, Charles@Wildnet.org
Paul Thomson, *Wildlife Conservation Network*, Paul@Wildnet.org

The Wildlife Conservation Network (WCN) is excited to announce the launch a new Sea Otter Fund. With the goal of deploying new funding to recover sea otters across their historic range, this fund is dedicated to supporting conservationists by providing 100% of the raised funds to individuals and organizations actively working on these efforts.

The fund's innovative structure includes a dedicated Fund Director who collaborates with stakeholders to develop strategic priorities, and an independent Granting Committee with a rotating membership to ensure dynamic and effective grant-making. WCN has extensive experience with Wildlife Funds, having established initiatives for species such as elephants, lions, pangolins, rhinos, and mountain lions. For example, the Elephant Crisis Fund has granted over $38 million to 500 projects through 115 partners. Its bold and adaptive approach was recognized by a European Union commission as the most impactful initiative in addressing the ivory crisis. We are confident that the Sea Otter Fund can have a similarly transformative impact by supporting the individuals, organizations, and institutions that have tirelessly advanced sea otter reintroduction efforts for decades.

The IUCN otter specialist group

Nicole Duplaix, *IUCN SSC Otter Specialist Group,* nduplaix@osu.edu

The otter specialist group (OSG) is one of the largest and most successful Species Survival Commissions (SSC) in the International Union for the Conservation of Nature (IUCN). Co-chair and founder Dr. Nicole Duplaix will discuss the OSG and how otter researchers and advocates can get involved.

SESSION 8

Rescue/Rehabilitation

Moderator: Randall Davis

Impacts of apprenticeship in sea otter conservation

Aliah Meza, *The Marine Mammal Center,* mezaa@tmmc.org

Share the impacts of a new apprenticeship position at The Marine Mammal Center in our sea otter conservation program. This position is funded by a USFWS Prescott Grant and based in our San Luis Obispo Operations where the majority of our sea otter strandings are located. The addition of this role allowed to improvements in our sea otter response readiness and post-release monitoring of rehabilitated sea otters.

Planning updates from the WDFW oil spill team

Montana McLeod, *WDFW,* montana.mcleod@dfw.wa.gov

The Washington Department of Fish and Wildlife (WDFW) is part of Washington state's oil spill program led by Washington Department of Ecology. The department's oil spill team provides technical expertise about the needs of fish and wildlife resources affected by oil spills. The team responds to oil spills 24 hours a day. The Oil Spill Team wishes to share a brief update on preparedness for oiled sea otter response, including new equipment, streamlining gear deployment, and plans to update the Washington Oiled Sea Otter Response Handbook.

Southern sea otter stranding update

Colleen Young, *CDFW,* colleen.young@wildlife.ca.gov

Stranded southern sea otters have been systematically documented and examined in California since 1968. Stranding patterns for 2023 and 2024 will be presented with comparisons to longer-term trends. The annual number of documented stranded sea otters has oscillated during the last decade, with a record of 474 in 2016, a low of 266 in 2022, and more than 400 in 2024. Demographics of stranded sea otters have fluctuated but are generally male-biased and in recent years have been biased towards younger (pup – subadult) animals. The geographic spread of strandings has mostly mimicked the distribution of the population, with typically fewer than 10 strandings outside the established range (Pigeon Point, San Mateo Co. to Gaviota, Santa Barbara Co.). Shark bites continue to be a significant cause of mortality for southern sea otters. Other notable causes of stranding will be presented.

SESSION 9

Physiology

Moderator: Lindy McMorran

Morphological and physiological adaptations in sea otters support a resting mass-specific metabolic rate 2.9 times higher than that of terrestrial mammals

Randall Davis, *Texas A&M University,* davisr@tamug.edu

Breathing (ventilation) is the physiological process of moving air in and out of the lungs to facilitate gas exchange, maintaining oxygen (PO_2; ~100 mmHg) and carbon dioxide (PCO_2; ~40 mmHg) levels in the alveoli and arterial blood, regulated by the brain's respiratory center. When oxygen consumption (VO_2) and carbon dioxide production (VCO_2) increase, ventilation rises to keep alveolar and arterial PO_2 and PCO_2 stable. Sea otters have resting levels of VO_2 and VCO_2 that are 3 times higher than the allometric prediction for a terrestrial mammal of similar size, a rate equivalent to light exercise in a terrestrial mammal. This heightened metabolic rate is an adaptation for thermoregulation in the marine environment, necessitating a threefold increase

in ventilation, as measured by minute volume (MV), which is the total air volume inhaled and exhaled per minute, determined by tidal volume (VT, air volume per breath) and respiratory rate (RR). To achieve this higher MV, sea otters have evolved lungs that are three times larger than predicted, which would increase MV if their RR matched the allometric prediction. However, their RR is only 57% of the expected rate, so they compensate with a tidal volume 5.3 times higher than predicted. This elevated tidal volume enhances alveolar ventilation, supporting efficient gas exchange and maintaining normal PCO_2. These respiratory adaptations show that an increased tidal volume, rather than respiratory rate, can optimize gas exchange efficiency to meet elevated metabolic demands while also enhancing buoyancy at the surface, a crucial adaptation for an aquatic lifestyle.

Northern sea otters (*Enhydra lutris*) as indicators of changing mercury dynamics in Kachemak Bay

Natalie Hunter, *Seward Sealife Center,* natalieh@alaskasealife.org

Mercury (Hg) is a naturally occurring heavy metal that has adverse health effects at high concentrations in various species. In Alaska, climate change is expected to affect the transport and fate of Hg in the environment, which could pose significant risks to wildlife and coastal communities that rely on healthy natural resources. Northern sea otters (Enhydra lutris) are a keystone species for the health and diversity of nearshore ecosystems. Their small home range and local foraging make otters an ideal sentinel species for identifying contaminant and pathogen presence in the local environment and identifying potential spatiotemporal trends. This study sought to quantify total Hg concentrations in hair (n=31), muscle (n=30), liver (n=31), kidney (n=32), and brain (n=23) tissues and in whole blood (n=18) from deceased stranded Northern sea otters from Kachemak Bay, Alaska. Archived samples from 2004-2023 were analyzed to determine how Hg is stored throughout the body and assess if variation in total Hg is associated with individual intrinsic factors. Preliminary results indicate that hair (1.40 ± 0.01, µg/g dw) and kidney (1.69 ± 0.03, µg/g ww) samples have higher total Hg on average than whole blood (0.05 ± 0.00009, µg/g ww) and muscle (1.17 ± 0.00003, µg/g ww) samples. These data will be the basis for long-term monitoring of Hg within Kachemak Bay and better aid management agencies that monitor these sea otter populations.

Nasopulmonary mites as potential vectors of *Streptococcus phocae* in southern sea otters: investigating their role in respiratory disease transmission

Ashani Hangawatte, *Ohio State University,* hangawatte.1@osu.edu

Sea otters are often infested with nasopulmonary mites (NPMs), an obligate endoparasites that inhabit the respiratory tracts of marine mammals. Their feeding behavior, characterized by piercing mouthparts, causes significant tissue damage, respiratory illnesses, secondary infections, and death under severe conditions. Recent studies have shown that NPMs may play a critical role in facilitating infections by harboring pathogenic bacteria, such as *Streptococcus phocae*, an opportunistic pathogen associated with severe conditions like pneumonia, septicemia, and abscessation in southern sea otters. However, the role of NPMs as potential vectors of *S. phocae*—whether mechanical or biological—remains unclear. We hypothesize that NPMs may serve as biological vectors of *S. phocae*. To investigate this, our objective is to determine the anatomical localization of *S. phocae* within NPMs using single-cell RNA fluorescence in situ hybridization (FISH). This method employs fluorescently labeled RNA markers specific to *S. phocae*, enabling visualization of bacterial presence in key anatomical regions of the mites, such as salivary glands and midgut. If *S. phocae* is confined to the digestive tract, this would suggest bacterial acquisition during feeding, implying a lower likelihood of direct transmission. Conversely, bacterial presence in salivary glands would indicate a higher risk of transmission to marine mammal hosts. Understanding the vector potential of NPMs is essential for addressing respiratory infections in marine mammals and contributes to improved management strategies for diseases impacting these ecologically significant species.

Population impacts of domoic acid exposure in southern sea otters: an increasing threat in a changing climate

Megan Moriarty, *University of California Santa Cruz,* mmoriart@UCSC.edu

Biotoxins produced by harmful algal blooms can have profound detrimental effects on individual marine mammals, yet population-level impacts are not well characterized. Southern sea otters are a threatened species that faces many environmental hazards, including phytoplankton-produced domoic acid (DA), which causes neurological and cardiovascular disease. In previous research, we conducted a survival analysis that followed free-ranging radio-tagged sea otters over time and incorporated environmental DA monitoring datasets. We found that high DA exposure over the previous year increased the risk of fatal heart disease. Here we evaluate the impact of future DA exposure on sea otter population viability using an integrated population model (IPM), a stage-structured, spatially explicit matrix model that uses animal health, population trends, and survival data to project abundance. The IPM was modified to allow for DA exposure effects on DA intoxication and cardiomyopathy hazards. We conducted a series of alternative scenarios to investigate how projected increases in frequency and severity of future DA events translated into changes in projected abundance of sea otters in 50 years, relative to a baseline scenario. Baseline DA event frequency and severity were based on observed values throughout the southern sea otter range over the past 20 years. If the

frequency and severity of DA events increased six-fold, abundance would be 2,839 (95% CI: 1,116-4,920), a 34% reduction from baseline. When co-stressors increased in parallel with DA events, impacts on population growth were substantial. Our findings have implications for conservation of vulnerable marine mammals in a changing climate.

Successful eradication of nasal mites (*Halarachne spp*.) in northern and southern sea otters (*Enhydra lutris kenyoni* and *Enhydra lutris nereis*) with oral milbemycin oxime and lufenuron (Sentinel®)

Matt O'Connor, *Georgia Aquarium,* moconnor@georgiaaquarium.org

Nasopulmonary acariasis caused by the *Halarachne spp.* nasal mite is a well-documented parasitic disease described in both free-ranging and managed sea otter (*Enhydra lutris*) populations. Left untreated, nasal mites have been shown to cause significant morbidity over time and even cases of mortality. However, eradication of the parasite can prove problematic. Historically, some institutions have employed 0.3 mg/kg ivermectin intranasally or rectally with mixed results. Over time the mite population rebounded and developed resistance to ivermectin. A previous study demonstrated successful treatment with transrectal selamectin administered every two weeks for six doses, though this required sedation or physical restraint. Here, the efficacy of monthly oral milbemycin oxime and lufenuron was evaluated. Six sea otters (two *E.l. kenyoni* and four *E.l. nereis*) were treated based off of recommended Sentinel® canid doses (i.e. 11-25 lbs = 120.75 mg, 26-50 lbs = 241.5 mg and 51-100 lbs = 483 mg). Four sea otters received a total of 18 doses and two recent rescues (*E.l. nereis*) received a total of 11 doses with no adverse effects noted. Opportunistic exams were performed under general anesthesia and the nasal passages were examined with an otoscope or a flexible rhinoscope. The first recheck nasal exam was performed after 3 total treatments and no nasal mites were observed. To date, no nasal mites have been observed 18 months after treatments ended. These results support the use of oral milbemycin oxime and lufenuron for the treatment of nasal mites in sea otters.

Protozoal encephalitis in live-stranded southern sea otters: antemortem diagnosis, treatment, and future directions

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Systemic apicomplexan protozoal infections in live-stranded Southern sea otters (*Enhydra lutris nereis*; SSO) present significant diagnostic and treatment challenges. Exposure to Toxoplasma gondii and/or *Sarcocystis neurona* was documented in 78% of sampled otters (421/541) over a 15-year period (1998-2012), and was a primary or contributory cause of death for at least 20% (108/547) of these cases.1 Currently, antemortem diagnosis of clinically relevant protozoal infection is primarily through serology,2 and while a positive result appears to indicate infection, observed serologic titers often do not correlate with reported clinical and/or histopathologic disease.1 From May 2017 through December 2024, 76% (38 of 49) of live-stranded sea otters admitted for rehabilitation at The Marine Mammal Center (Sausalito, CA, USA) were serologically positive for *T. gondii, S. neurona*, or both parasites at titers ≥320 serum dilution on the indirect fluorescent antibody test (IFAT)2. Twenty-eight of 38 seropositive otters died or were euthanized within 6 days of stranding, before a diagnosis was established. Four of 38 were seropositive but not treated with antiprotozoal medication as they did not exhibit neurologic signs; three of these were released and one was placed in managed care due to an unrelated health issue. Five of the 38 seropositive displayed neurologic signs consistent with potential protozoal disease (tremors, ataxia, and/or generalized paresis). These five animals were treated with oral antiprotozoal medication (ponazuril and/or trimethoprim-sulfamethoxazole) for approximately four weeks, with variable patient compliance. Neurologic disease resolved in each case and all five otters were released. One treated individual re-stranded 7 months later with recurrent neurologic disease and declined despite care; *Toxoplasma gondii* was cultured from brain tissue postmortem. Inconsistencies among clinical presentation, serologic results, and patient outcome highlight the need for improved, rapid, and accurate antemortem diagnostic capabilities for this threatened species. Future directions include investigation of PCR on whole blood samples from live-stranded sea otters, and identification of genotypes associated with more severe protozoal disease.

SESSION 10
Diet

Moderator: Michelle Staedler

Sea otters decrease size and catch of southeast Alaska's crab species

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As the sea otter (*Enhydra lutris*) population of southeast Alaska increased from ~400 translocated individuals to over 22,000, concerns have grown over potential negative impacts on commercially fished species. However, southeast Alaska continues to support a productive Dungeness crab (*Metacarcinus magister*) fishery, despite the growing sea otter population. We explored whether Dungeness crab use a depth refuge to avoid sea otter predation as a possible hypothesis to explain coexistence of Dungeness crab and sea otters. In addition to Dungeness crab, we tested for the effects of sea otters on five other crab species: Tanner crab (*Chionoecetes bairdi*), lyre crab (*Hyas lyratus*), red king crab (*Paralithodes camtschaticus),* helmet crab (*Telmessus cheirogonus),* and decorator crab (*Oregonia gracilis*). We found no evidence of a depth refuge for any crab species, including Dungeness crab. Catch of both Dungeness and Tanner crab were lower at sites with longer sea otter occupation. Additionally, longer sea otter occupation time was associated with decreased size of male Dungeness crab, male and female lyre crab, male king crab, and male helmet crab. Our results demonstrate that sea otter predation pressure can have significant negative effects on crab catch and size, particularly in larger species and sexes. Depth refugia do not explain the coexistence of Dungeness crab and sea otters, and our future work explores alternative hypotheses.

Sea otter foraging at incipient kelp forests as a natural ecosystem recovery mechanism

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The continued lack of kelp forest recovery following widespread loss in California over the past decade has created great interest in approaches to restoration that include leveraging natural mechanisms of recovery. In recent years, small-scale incipient forests (bull kelp, *Nereocystis luetkeana* and giant kelp, *Macrocystis pyrifera*) have been documented along California's central coast region in areas that were recently dominated by herbivorous purple sea urchins (*Strongylocentrotus purpuratus*). These incipient forests present a unique and timely opportunity to evaluate the physical and biological conditions associated with natural kelp forest recovery. Here, we present an update on a two-year project aimed at understanding mechanisms of kelp forest recovery. In particular, we evaluate sea otter occupancy time, foraging rates, and consumed biomass of sea urchins at incipient kelp forests and habitat margins. By

understanding the spatial distribution of sea otter foraging on sea urchin prey relative to locations of incipient kelp forests, persistence kelp forests, sea urchin barrens, this study can guide siting for restoration, fine tune the timing of intervention and methods used, and be incorporated into ecological forecast models.

Green crabs: breakfast of champions

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Understanding the role of apex predators on ecosystems is essential for designing effective conservation strategies. Supporting recovery of apex predators can have many benefits; one that has been rarely examined is control of invasive prey. We investigated whether a recovering apex predator, the southern sea otter (*Enhydra lutris nereis*), can exert local control over a global marine invader, the green crab (*Carcinus maenas*). We determined that southern sea otters in Elkhorn Slough estuary in California can consume large numbers of invasive green crabs and found strong negative relationships in space and time between otter and green crab abundance. Green crabs persisted at highest abundance in this estuary at sites with artificial tidal restriction that were not accessible to otters. Green crab abundance remained lower in this estuary than in all other estuaries in the region, which lack resident sea otters. Conservation organizations and agencies have invested heavily in recovery of southern sea otters, increasing their numbers in this estuary. Restoration of natural tidal exchange and lost marshes and seagrass beds further supports their populations. We have demonstrated that these investments in top predator recovery and habitat restoration have reduced the impacts of a global invader. Our investigation highlights that investment in recovery of top predators can increase beneficial food web interactions and resilience of the entire ecosystem.

Northern sea otter foraging analysis in Washington state

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Northern sea otters were translocated from Alaska to Washington in 1969/1970 to repopulate a previously occupied area within their range. The native otters had been extirpated during the Pacific maritime fur trade, and the last Washington sea otter was hunted in 1911. Fifty nine animals were translocated from Amchitka Island, Alaska to the outer coast of Washington, where the population has now grown to over 3,000 individuals. To access sea otter population growth impacts to the nearshore, foraging data was collected by the Seattle Aquarium on a monthly basis from various locations in Washington between Neah Bay and Kalaloch (2010–2024). Here, we present a preliminary analysis of diet using a Bayesian model, Sea Otter Foraging Analysis (SOFA3.2).

Posters

Chugach Imaq Initiative

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Since 2020, the Chugach Regional Resources Commission (CRRC) has been working towards a marine mammal harvest and management strategy. With financial support from the NDN Collective, Alaska Center for Climate Assessment and Policy, and Marine Mammal Commission, CRRC created the Chugach Imaq Initiative in 2022. Imaq in Sugt'stun refers to "the ocean, the saltwater, and its contents". Chugach Regional Resources Commission (CRRC) founded the Chugach Imaq Initiative to develop marine mammal harvest management plan that prioritizes the conservation and benefit of sea otter species in the Chugach region. On behalf of the seven Chugach communities, CRRC is working towards revitalizing Tribally-led stewardship of traditional territories and sea otters through co-management relationships with the US Fish and Wildlife Service (USFWS) with a regional focus that centers on Tribal sovereignty. So far, Chugach Imaq has developed Indigenous-led biosampling from subsistence harvests to understand the health and well-being of our sea otter subsistence species, promoted

culturally respectful collaborative research, identified gaps in research and monitoring, worked with the Indigenous Sentinels Network to provide app-based research and monitoring support to Tribal communities, and built a collaborative foundation for coproducing science with regional and federal partners through the Chugach Imaq Research Collaborative (CIRC) to support co-stewardship of sea otters and ecosystems in the Chugach region. A founding tenet of CIRC is that direct scientist-to-scientist collaboration among staff within the participating organizations can best establish lasting relationships among Tribes and agencies with a mutual responsibility for stewardship of coastal resources.

Sea otter (*Enhydra lutris lutris*) foraging ecology at Cape Kiritappu, Hokkaido, Japan

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Sea otters, once on the brink of extinction due to commercial hunting, are in worldwide recovery. In Japan, the endangered species is reoccupying portions of its historical range and forming small, fragmented populations along eastern Hokkaido. One such population has settled off Kiritappu, a remote cape first recolonized in 2014. The return of sea otters to the area, however, has incited concern from local fishing communities over possible resource competition. In November 2024, initial foraging data was collected to begin determining the extent of human-sea otter overlap in marine resource use. Subsequent analysis showed an overall foraging success rate of 86.14% and relatively low diet diversity (H = 1.27). Kiritappu sea otters were observed consuming a total of four prey types, with the average diet consisting of crabs (32.1 ± 18.8%), clams (32.1 ± 36.0%), urchins (23.7 ± 36.9%), and snails (12.0 ± 26.8%). Preliminary results suggest they may be selectively targeting calorie-dense prey that are easy to capture, as predicted by optimal foraging theory. Ongoing data collection and analysis in this multiyear study will better quantify sea otter diet, giving clarity to the species' prey preferences. Future findings are also expected to reveal the recovering population's direct impact on commercially valuable prey and improve our general understanding of sea otter foraging ecology in Japan.
