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BOOK OF ABSTRACTS

(alphabetical order by last name)

EVALUATING THE INFLUENCE OF FLUCTUATING OCEAN CONDITIONS ON FORAGING ECOLOGY AND BREEDING ACTIVITY OF A THREATENED SEABIRD

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Physical and chemical properties of the world's oceans have become more dynamic as a result of climate change, and biological responses in marine food webs are poorly understood. The Northern California Current System experienced the warmest conditions on record during the 2010s, with well-documented consequences to marine food webs. We sought to examine the foraging and breeding response of a threatened seabird, the Marbled Murrelet (*Brachyramphus marmoratus*), to varying ocean conditions. Marbled Murrelet adults are known to exploit prey in a range of trophic levels, but breeding may be curtailed if forage fish of the appropriate size for provisioning offspring are limited. Examination of stable isotopes in body tissues allows for evaluating diet in a non-invasive manner, and can reveal how predator diets are affected by fluctuating ocean conditions. We captured 223 Marbled Murrelets off the central Oregon coast during spring of 2017-2019, when indices of upwelling showed progressive strengthening. We measured stable isotope values of nitrogen in blood to infer inter-annual variation in prey use. Although murrelet breeding propensity was low overall, we found that in the year with the highest breeding propensity, murrelets fed at lower trophic levels during the pre-breeding period. This finding may indicate that some murrelets initiate breeding when zooplankton are abundant due to an early transition to upwelling. This early abundance of zooplankton may also provide a signal indicating the availability of forage fish later in the season to support chick provisioning. Our finding suggests an important connection between the timing of the spring transition to upwelling and murrelet breeding propensity.

GEOGRAPHIC STRUCTURING OF EMPEROR AND ADELIE PENGUIN AND WEDDELL SEAL COLONIES IS INTERCONNECTED

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Evidence increases that seabirds don't act alone, as competing species have major influence on seabirds' abundance and distribution. We recently reported the geographic structure of Emperor (*Aptenodytes forsteri*) and Adélie (*Pygoscelis adeliae*) penguin populations in Antarctica, showing that intraspecific competition for food affects colony size and distribution. Simultaneously we have been assessing the geographic population structuring of the Weddell seal (*Leptonychotes weddellii*), which like emperor penguins require fast sea ice for location of breeding colonies. By combining remote-sensed, very high-resolution satellite imagery, community science, and habitat modelling, besides deriving a Weddell seal global population estimate, we report the physical and biological factors that influence seal distribution at regional and continental scales. Logistic regression modelling revealed regional differences among variables, with proximate ocean depth and fast ice variables being consistently important in explaining seal prevalence. Moreover, distances to colonies of both penguin species, being trophic competitors of seals, influenced probability of seal presence, and emperor penguin colony size had a strong inverse interaction with Weddell seal colony size: more seals, fewer penguins. On the basis of this body of analyses, we suggest that greater attention be made to understanding the community ecology of upper trophic level vertebrates relative to the preyscape, especially in regard to potential intraspecific and interspecific competition or niche partitioning. The seal-penguin interaction could be used as a model for other systems in which marine mammal-seabird (and predatory fish) complementary relationships exist.

ENVIRONMENTAL CONDITIONS EFFECT ON HORMONE LEVELS IN WESTERN GULLS (LARUS OCCIDENTALIS)

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Climate fluctuations have tremendous effects on seabirds' life histories, e.g. adverse climate conditions leading to nest abandonment, increased mortality or even to skipping breeding in seabird's population. Hence, hormones play an important role in regulating physiology and behavior of an individual and are essential for adequate adaptation to a changing environment. Still, little is known how climatic variability affects breeding physiology and behavior in seabird and their long-term consequences on their offspring. In 2 consecutive breeding seasons, we have observed a change in the aggressive behavior of incubating Western gulls. Thus, in this study, we investigate the maternal effect of breeding female Western gulls in relation to their aggressiveness. We quantified testosterone and corticosterone concentration in egg yolk in both years in relation to their mother's aggressiveness. Our results let us speculate on possible consequences of climate change on reproductive output and chick survival on gull populations. Further detailed analyses are being conducted at this time and will be updated at the conference.

FIRST REPORT OF HOUSE MICE DENSITY INDEX IN A MAJOR BREEDING COLONY OF PERUVIAN DIVING-PETRELS IN PERU

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Peruvian diving-petrels (*Pelecanoides garnotii)* are globally Endangered. In Peru, the bulk of the Peruvian diving-petrel population breed on two islands: La Vieja and San Gallán, where 35,000 active burrows were counted in 2009. The presence of mice was first anecdotally reported on Isla La Vieja in the early 2000s, but no species identification, index of abundance and potential thread to the diving-petrels was determined. In February 2020, we started a project to plan the eradication of the rodents from Isla La Vieja (1,100 ha) whose activities included trapping for the identification of mice and estimation of its density, necropsies of trapped mice to determine their feeding habitats, counts of the diving-petrel population and estimation of birds´ breeding success in relation to mice abundance. Here, we provide the first results of the trapping survey undertaken between 29 Feb and 7 Mar 2020. A total of 60 transects were set inside and outside diving-petrel clusters (cluster = group of nests or subcolonies) located in three major zones on the island (west, east and south). Each transect contained 5 covered snap traps (d-CON) set at 5-m intervals and were set for three consecutive nights. All mice trapped were identified as *Mus musculus*. The captures per 100 corrected trap-night index (C100TN) varied across clusters between 2.4 ± 3.9 and 13.7 ± 16.9 inside the clusters, and between 0 and 5.4 ± 8.5 outside the clusters. Mice were present in all zones indicating that they have possibly invaded the whole surface of the island. The abundance of mice found in this survey show a potentially high risk for survival of diving-petrel chicks and eggs.

SPATIO-TEMPORAL MODELS PROVIDE VAST POSSIBILITIES FOR ANALYSIS OF AT-SEA SEABIRD SURVEY DATA

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Recent developments in spatio-temporal modeling approaches can improve our ability to estimate population trends, identify critical marine habitat, and inform management decisions with at-sea seabird survey data. Here we provide an example of how vectorized autoregressive spatio-temporal (VAST) models can be applied to at-sea survey data to model seabird densities within

potential oil and gas development areas in Cook Inlet, in the Northern Gulf of Alaska. We used the North Pacific Pelagic Seabird Database (NPPSD v3.0), a publicly available data archive for at-sea surveys conducted in the North Pacific since 1973. We applied VAST empirical orthogonal function analysis to model monthly density distributions of nine species over time. Factor loadings for spatio-temporal variation across months indicated the dominant mode of variability explained 65% of the variance, and was positively associated with seabird densities during the breeding season (June-August). The second dominant mode of variability explained 35% of the variance and was positively associated with months that occur primarily during the non-breeding season (August – October, February). Seasonal trends indicated that for the majority of species examined, (*Brachyramphus* murrelets, murres, shearwaters, kittiwakes, puffins) abundance peaks in June-July. Cormorants and pigeon guillemots are an exception in that higher densities also occurred in Cook Inlet during late-winter/spring. Spatially explicit monthly density predictions will inform efforts to assess risk and mitigate impacts of resource development.

CARRY-OVER EFFECTS OF ENVIRONMENTAL STOCHASTICITY OF THE CALIFORNIA CURRENT ON BODY CONDITION AND WING LENGTH OF BREEDING BLACK-VENTED SHEARWATERS (*PUFFINUS OPISTHOMELAS*)

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When climate variability is on the agenda, seabirds come up with creative solutions to optimize their foraging strategy: some fly further, dive deeper, catch a different prey, gain weight, enlarge their wing span, do not have dinner with their partner. Due to selection or phenotypic flexibility, if a new environmental condition persists, seabirds' answer can be a morphological shift that differs between the sexes, as a consequence of their different metabolic investments. Thus, especially with an unfriendly climate the birds' body condition may be poor at the time of breeding, or have a carry-over effect in the post-breeding season, while feathers' moult happens. By analysing biometrics of Black-vented Shearwaters caught at Isla Natividad (Mexico), we test whether investment-related flexible traits (body condition, flight feather length) vary with environmental stochasticity from 2016 to 2019. This period followed a "warm-blob" in 2014–2015, and conditions varied annually with a strong El Niño event in 2015–2016, a gradual change to weak La Niña conditions in 2016–2017 and 2017–2018, and returning to weak El Niño in 2018-2019. We found a clear effect of sex and environmental conditions with females responding more sensitively to environmental variability effects on body condition and wing feathers growth. Such difference might be explained by the higher metabolic cost associated with reproductive effort during egg production. The variability in biometrics observed during the study period, reflects

individuals' efforts to cope with environmental fluctuations that induce resource scarcity. This flexibility may be increasingly important in coping with more frequent unfavourable warmer events such as El Niño and Warm Blob.

YEAR-ROUND NICHE SEGREGATION OF THREE SYMPATRIC *HYDROBATES* STORM-PETRELS FROM NORTHWEST MEXICO, EASTERN PACIFIC

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Ecologically similar species partition their use of resources and habitats and thus coexist due to ecological segregation in space, time, or diet. In seabirds, this segregation may differ over the annual cycle or vary inter-annually. We evaluated niche segregation in three sympatric storm-petrel species (*Hydrobates melania*, *Hydrobates leucorhous*, and *Hydrobates microsoma*) from the San Benito Islands, Mexico, during 2012 and 2013. We used diet samples and carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopic values obtained from egg membranes, blood, feathers, and prey. We used krill samples to delineate marine $\delta^{13}C$ and $\delta^{15}N$ isoscapes for the Baja California Peninsula. During the breeding season, storm-petrels segregated regarding diet composition, stable isotope values, and isotopic niches. *Hydrobates melania* consumed higher trophic-position prey from neritic waters, while *H. leucorhous* and *H. microsoma* foraged on lower-trophic position prey from oceanic waters. Isotopic niches among species did not overlap in 2013, whereas those of *H. microsoma* and *H. leucorhous* largely overlapped in 2012. The feeding strategies of *H. melania* varied among breeding phases, and adults consumed different prey items from different areas compared to those of their offspring. *Hydrobates microsoma* adults and their chicks consumed the same prey items but from different habitats. During the non-breeding period, niche segregation between species persisted, except for *H. microsoma* and *H. leucorhous* during the molt of P1 and undertail cover feathers. These three sympatric species coexist through niche segregation based on prey items and foraging areas that vary seasonally and year-round probably, due to changes in oceanographic conditions and the distribution and availability of prey.

EARLIER AND MORE FREQUENT NON-BREEDING COLONY ATTENDANCE INCREASES BREEDING SUCCESS IN COMMON MURRES

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Competition for high quality breeding sites in colonial seabird species is often intense, such that individuals may invest considerable time in site occupancy even outside of the breeding season. The site defence hypothesis predicts that higher quality (i.e., more productive) sites will be occupied earlier and/or more frequently. Individuals occupying those sites may then benefit from an earlier initiation of breeding, and breed more successfully. In Common Murres (*Uria aalge)* previous studies of site attendance in the fall on the Isle of May (UK) have found evidence of breeding site defence with more successful sites occupied earlier and more frequently. Here we extend this approach and test how site-level attendance throughout the non-breeding period (October-March) related to site quality, breeding timing and breeding success at c.80 Murre sites over three years. Using time-lapse photography, we determined the first date that sites were occupied, and how often sites were attended. We then monitored subsequent breeding timing (lay date) and success. Higher quality sites were occupied earlier and more often (for a greater proportion of days) throughout the non-breeding period. Sites occupied more often had significantly earlier lay dates, and those occupied earlier were more successful, supporting the site defence hypothesis. A path analysis showed that first return date had a direct effect on breeding success and was a better predictor of success than lay date. This clear effect of non-breeding attendance on breeding timing and success highlights the potential fitness benefits of this behaviour on life-history processes.

REDUCING ANTHROPOGENIC SUBSIDIES CURBS DENSITY OF AN IMPORTANT MARBLED MURRELET NEST PREDATOR IN A PROTECTED AREA

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Protected areas safeguard biodiversity and provide opportunities for human recreation. However, abundant anthropogenic food subsidies in protected areas can lead to high densities of generalist predators that can threaten rare species. Reducing subsidies could curb populations of predators, yet the effectiveness of this strategy is unclear. We characterized changes in the foraging ecology, body condition, and demography of a generalist predator, the Steller's jay, after implementation of a multi-faceted management program to reduce anthropogenic subsidies in a California state park that protects nesting habitat for a threatened seabird, the marbled murrelet. Stable isotope analysis revealed that the proportional contribution of anthropogenic foods to jay diets declined from 88% to 47% in response to management. Overlap between jay home ranges decreased after management began, while home range size, body condition, and individual fecundity remained stable. Adult density in subsidized areas decreased markedly after the initiation of management, whereas density in unsubsidized areas that

were not expected to be affected by management remained stable. Thus, the response of jays to management was density-dependent such that reduced densities facilitated the maintenance of individual body condition and fitness. Importantly, though, jay population size and collective reproductive output declined substantially, likely decreasing the risk of marbled murrelet nest predation. Our study provides evidence that limiting anthropogenic subsidies can successfully reduce generalist predator populations and be part of a strategy to increase compatibility of species protection and human recreation within protected areas.

EFFECTS OF SEA LEVEL RISE ON NESTING POPULATIONS OF COLONIAL BIRDS IN BARNEGAT BAY: 1976 TO 2018

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We monitored population levels, habitat use, and concentrations of heavy metal levels in colonially-nesting birds in Barnegat Bay since 1976. Colony sites were monitored several times/year. The number of nesting pairs (and colony sites) of Common Terns, Forster's Terns, Black Skimmers, Laughing Gulls, and Herring Gulls decreased significantly, although reproductive success did not decrease. Great Black-backed Gulls increased markedly partly because they are significantly larger and arrive on the nesting colonies earlier; they outcompete smaller species of gulls and terns. Great Egrets increased as nesting birds in Barnegat Bay, while Snowy Egrets and others egrets and night-herons have declined. The most notable change in Barnegat Bay is a loss of nesting islands, and degradation of some of the remaining habitat, due mainly to sea level rise. More than half of the islands used by Common Terns have disappeared or degraded. Sea level rise is greater in the northeastern Atlantic coast than in other parts of the world. Many islands have disappeared or become sub-optimal for nesting. Whether an island is useful for nesting depends upon the species. The habitat for species, such as terns, that nest on low-lying islands disappeared first, and these islands eventually were inundated and destroyed. Shrub-nesting species (egrets) have not lost nesting habitat. Except for mercury, most metals have declined over this same time period, indicating they are not likely to contribute to the overall declines.

LEMONS INTO LEMONADE: TERN SURVEYS IN THE TIME OF COVID-19

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The Aleutian Tern (*Onychoprion aleuticus*) is a species of conservation concern in Alaska due to dramatic declines over the last several decades. Unfortunately, conservation planning is limited by the lack of information on critical aspects of biology and the general inadequacy of colony abundance data. In the 1970s Aleutian terns were studied extensively at colonies on Kodiak Island as part of the Outer Continental Shelf Environmental Assessment Program, resulting in some of the most detailed information on both colony size and biology in Alaska. While periodic surveys have been conducted by the U.S. Fish and Wildlife Service since that time, we have been unable to re-visit all known tern nesting

sites in the Kodiak Archipelago in a single breeding season. Due to the COVID-19 pandemic biologists with Kodiak National Wildlife Refuge were unable to hire the seasonal employees necessary to conduct planned at-sea multispecies marine bird monitoring surveys. However, we saw this as an opportunity to take a small crew and target all the known Aleutian tern colonies in the Kodiak Archipelago from 24 July – 5 August. Based on colony counts conducted during this time frame, we estimate the adult breeding population in the archipelago was 449 Aleutian terns at nine colonies, with evidence of nesting at seven of the nine sites. The highlight was the discovery of a 'new' colony on Aiaktalik Island with 230 Aleutian terns – the first nesting seen there since 2001. By opportunistically deploying resources normally committed to other tasks, we were able to complete a unique and valuable survey for the first time.

ATLANTIC PUFFIN DIET REFLECTS HADDOCK AND REDFISH ABUNDANCE IN THE GULF OF MAINE

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Ecosystem-based fisheries management, which considers the interactions between fisheries, target species, and the physical and biological components of ecosystems, is necessary to ensure that directed fisheries avoid adverse impacts to ecosystems over the long term. The successful implementation of ecosystem-based fisheries management requires an understanding of predator-prey relationships and ways to operationalize such relationships to inform fisheries management. Here, we investigate if the diet of a generalist predator, Atlantic puffins (*Fratercula arctica*), can be used as an indicator of the abundance of two commercially exploited prey species (haddock, *Melanogrammus aeglefinus*, and Acadian redfish, *Sebastes fasciatus*) in the Gulf of Maine. Because haddock and redfish are juveniles (age 0) when eaten by puffins, there is potential to use their proportions and lengths in puffin diet to better understand the processes influencing haddock and redfish recruitment. By using principal component analysis to develop measures of diet across multiple puffin colonies, we show both spatial variation and large-scale patterns in the proportions and lengths of haddock and redfish in puffin diet. Haddock length on one colony was a moderate predictor of age 1 recruitment. Spawning stock biomass was a strong predictor of haddock proportion in puffin diet and a moderate predictor of redfish proportion; however, proportions in puffin diet did not predict age 1 recruitment, suggesting that variation in recruitment is caused by processes that occur after the puffin breeding season and affect the survival of older juveniles. We conclude that puffin diet can be used as an indicator of haddock and redfish abundance.

MIGRATION AND WINTER HABITAT USE OF GLAUCOUS-WINGED GULLS FROM TRIANGLE ISLAND, BRITISH COLUMBIA

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Understanding the movements and habitat use of marine birds is essential to inform conservation and marine spatial planning. Here, satellite transmitters were used to study the migration and winter habitat use of adult Glaucous-winged Gulls (*Larus glaucescens*) from a colony in central British Columbia. Three of four tracked gulls overwintered locally, while the fourth followed a coastal migration route to northern California. All four gulls maintained small winter home ranges and spent an average of 72% of their time in nearshore coastal waters (average distance to coast: 0.6-1.7 km) characterized by low levels of anthropogenic activity. The remainder of their time was spent in naturally vegetated areas. One gull overwintered in an area with high human population density (northern California), with limited use of cropland (4% of locations) and urban (6% of locations) areas. This study is part of on-going efforts to understand the distribution and habitat use of marine birds throughout British Columbia to inform marine spatial planning and associated threats at various scales.

FIRST *IN SITU* REHABILITATION OF AN ʻUAʻU (HAWAIIAN PETREL, *PTERODROMA SANDWICHENSIS*) CHICK ON LĀNAʻI, HAWAIʻI

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Wildlife rehabilitation typically entails the rescue and captive maintenance of sick, injured, or orphaned animals, with a goal of returning those individuals to the wild once recovered. Here, we document the first *in situ* rehabilitation of an endangered ʻuaʻu (Hawaiian Petrel, *Pterodroma sandwichensis*) chick on Lānaʻi, Hawaiʻi, in fall 2020. This chick lost one of its parents to an introduced predator, a Barn Owl (*Tyto alba*), at approximately 70 days old. It was deemed unlikely to survive without intervention since both ʻuaʻu parents provision their chick, and the chick was still >1 month from fledging. With authorization from permit agencies, we undertook a supplemental feeding program that allowed the chick to stay at its natal burrow, where it could continue to interact with and receive food from its remaining parent, hear the surrounding colony, and fledge from its natural habitat. The chick was assessed 2-3 times per week for weight, wing chord, body condition, and attitude. Activity at the burrow was monitored using remote cameras positioned outside the entrance. If its parent had not visited the night before, the chick was fed a prepared fish slurry following feeding and growth targets developed from Pacific Rim Conservation's translocation work with the species on Kauaʻi. Initially underweight, the chick achieved a healthy growth curve, and based on behavior observed on camera, the chick apparently fledged at 113 days. Overall, the chick received care for 31 days, with 9 supplemental feedings over 14 visits, and 5 visits by the surviving parent. This work provides insight into ʻuaʻu chick growth and development, and presents an alternative to captive-rearing that may be advantageous in some circumstances.

A NEW OPTION FOR AT-SEA SURVEY DATA COLLECTION AND PROCESSING: SEALOG & QAQSEA

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Seabird biologists in Alaska have been conducting marine bird surveys since the 1970s. In the early 1990s, data collection shifted from paper data sheets to electronic data recording. For over 20 years, many researchers have used the dLOG application written by Glenn Ford to record data during marine bird surveys. The dLOG application was highly customizable; however, this flexibility often resulted in inconsistent output complicating post-processing and the data integration. To tackle this issue, biologists from several Department of Interior agencies and non-governmental partners in Alaska formed a working group to design a new data logging application, modeled after dLOG, with improvements in GPS connectivity, real-time editing, support for distance sampling, and standardized post-processing. Working with ABR Inc., the working group developed two software applications, the first app for collecting biological survey data and a second app to conduct quality assurance/quality control (QA/QC) and produce standardized outputs, including those associated with the North Pacific Pelagic Seabird Database (NPPSD). The new data logging application "SeaLog" uses 3 panels for (i) data entry, (ii) a map display with real-time platform location, and (iii) a running list of observations. SeaLog exports comma delimited files that are readable by the second application "QAQSea" which has QA/QC tools and flexible summary output options. These two applications are currently completing final testing and will be publicly available from the NPPSD website in March 2021.

ASSESMENT OF THE HEALTH STATUS OF FOUR SPECIES OF SEABIRDS IN RELATION TO POLLUTANTS

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Emerging pollutants and genotoxic substances are rapidly accumulating in all ecosystems, threatening a large number of organisms such as seabirds. Seabirds have a capacity to bioaccumulate toxic chemicals and are recognized as excellent environmental bioindicators since they are exposed to different kinds of stressors that can alter their physiology, behavior and also cause death. Nuclear anomalies were determined in erythrocytes of 121 individuals of four seabird species (*Pelecanus occidentalis, Puffinus opisthomelas, Larus livens and L. occidentalis*), characterized to present different reproductive state and different habitat at Archipelago Espíritu Santo, in Gulf of California, and at Isla Natividad on the western

coast of Baja California Peninsula. Acridine orange was used to stain blood smears by using a specific protocol developed for seabirds' blood. Stain slides were observed in an optical microscope and 20 digital photographs were taken by sample. Micronucleus and nuclear abnormalities are presented in 2000 erythrocytes per individual. Significant differences in the frequency of micronucleus and nuclear abnormalities between species and reproductive state were found, but no differences between geographic areas are reported. The highest relative frequency of micronucleus and nuclear abnormalities was found in chicks of black-vented Shearwater (*Puffinus opisthomelas*) (70% micronuclei frequency and 100% of nuclear abnormalities). The two gull species (*Larus livens and L. occidentalis*) living in two different study islands, presented the fewest of both suggesting that these species are less sensitive to genotoxic damage. There is no information about pollutant concentrations in seabirds from Northwest Mexico thus, this project is a pioneer and useful as baseline for future studies monitoring health status of seabirds in the area.

INDIVIDUAL CONSISTENCY IN SPACE-USE AND TIMINGS DURING THE NON-BREEDING PERIOD OF A TROPICAL SEABIRD, THE ROUND ISLAND PETREL

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Tracking individuals on repeated migratory journeys is proving key to understanding the evolutionary forces shaping migratory systems. This approach has been used to analyse the migratory consistency of various species, with implications for the understanding of how migratory systems may alter in response to environmental changes. However, few studies have addressed individual consistency for seabirds in the tropics, where individuals are often thought to perform less consistent migrations due to the lack of seasonally predictable food resources. Using a 10-year geolocator tracking dataset, comprised of 62 individuals with multiple non-breeding migrations, we examined individual consistency in the space-use and timings of a tropical seabird, the Round Island petrel (*Pterodroma* sp.). These tracking data have revealed extraordinary levels of individual variation in ocean movements, with petrels undertaking non-breeding migrations to different areas across much of the Indian Ocean. Despite this large between-individual variation, repeat tracking of individual petrels for up to 4 years indicates remarkably high levels of spatial consistency, with petrels departing at similar times having more similar migrations. However, individuals do not always use the same at-sea locations at the same time throughout the non-breeding period. Individual repeatability of arrival and departure dates, to and from Round Island, was also high ($R > 0.79$). This, together with the fact that birds can be found breeding on Round Island all year round, means that individuals are likely to be exposed to a very wide range of environmental conditions, with potentially important consequences at the individual- and population-level.

RETURN OF BREEDING WEDGE-TAILED SHEARWATERS FURTHER DEFINES SUCCESS OF FALLOUT RECOVERY EFFORT IN MAUI NUI

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Before modern-day humans, natural light from the moon and stars guided seabirds out to sea where they go to feed and mature. Today, our artificial lighting distracts and disorients these ancient animals. Seabirds circle artificial light sources or collide with man-made structures causing them to fall to the ground due to exhaustion or injury. Grounded seabirds are susceptible to predation and at risk of being hit by cars. To address this issue, known as fallout, the Maui Nui Seabird Recovery Project (MNSRP) initiated Save Our Seabirds. This program depends on citizens to notify the MNSRP of grounded seabirds. Once notified, staff members respond to the call, collect the grounded seabird, and conduct an assessment. Most birds are banded and released within 24 hours of recovery.
The majority of fallout birds recovered by the MNSRP are Wedge-tailed Shearwaters (*Ardenna pacifica*). The MNSRP also manages an established banding program for Wedge-tailed Shearwater colonies on Maui Nui. By combining our fallout dataset with our long-term mark-recapture dataset for Wedge-tailed Shearwaters, we are able to report on the success of fallout recovery for the first time. From 2002 to 2015, we banded 483 hatch-year fallout birds, of which 19 have been recaptured in a colony (3.93% recovery rate). From 2002 to 2020, we banded 175 after-hatch-year fallout birds, of which 5 have been recaptured (2.86% recovery rate). Our findings provide leading evidence that fallout recovery efforts are worthwhile. With artificial light levels increasing every year, the average annual Wedge-tailed Shearwater fallout is also increasing. Thus, we anticipate more returning fallout birds to show up in the Maui Nui colonies in the years to come.

FORAGING AND PARENTAL CARE STRATEGIES IN THE COLONY OF *FREGATA MAGNIFICENS* IN THE ESPÍRITU SANTO ARCHIPELAGO, MEXICO

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The population size of the Magnificent Frigatebird (*Fregata magnificens*) is decreasing in most of the areas for which data are available. Currently, the species is not under any protection. Among the possible causes of population declines in most areas are habitat destruction and disturbance at their colonies. Historically, the largest colony of Magnificent Frigatebirds in the world hosted 20,000 breeding pairs on Margarita Island; however, for unknown reasons, the colony collapsed. Today, the largest colony in the state of Baja California Sur is in Bahía San Gabriel, on Espíritu Santo Archipelago. The socio-environmental context in which this colony is located is characterized by constant tourist activity around the Archipelago and in the bay, that could have an impact on the abundance and demography of the

bird population. It is therefore necessary to expand the knowledge about the life history of this species to propose conservation measures. Working with GPS tracks, we determined that adults use the peninsula coastal water during most of the year, with males moving north and south during the winter and females staying close to the colony, moving mainly between the Gulf of California and the Pacific Ocean. The different foraging strategies are likely related to different parental strategies, as nest cameras revealed that the females invested more time and energy in the late chick rearing period to feeding the chicks and being present in the nest.

BREEDING SUCCESS OF A MIGRATORY SEABIRD FOLLOWING EXTREME WEATHER CONDITIONS

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Extreme weather events are increasing in frequency, causing disruption to global ecosystems. Large-scale events, such as marine heatwaves, can impact the abundance of prey species, which consequently influences the behaviour of top-level predators such as seabirds. The short-tailed shearwater (*Ardenna tenuirostris*) is a trans-hemispheric migrant with, until recently, a highly synchronous breeding phenology. This study documents shearwater breeding ecology for the period 2011-2020, with particular reference to the 2019/20 season that followed a marine heatwave that occurred predominantly in their non-breeding grounds in the North Pacific Ocean. The birds arrival to their breeding grounds in southeast Australia was delayed by approximately two weeks in October 2019, and the subsequent breeding season resulted in only 34% breeding success, with nest abandonment beginning in the incubation phase. Egg and chick failures during the breeding season were likely influenced by the marine heatwave that reduced adult body condition and ultimately led to a mass mortality event of over 9000 birds ('wreck' of beach-washed birds) in 2019; however, localised weather events (i.e., flooding of burrows due to heavy rainfall) also influenced breeding outcomes. The relationship between wreck events and seabird breeding ecology is an understudied area, partly due to the difficulties around quantifying the scale of the wrecks. There is a need for more rigorous reporting of seabird wrecks to allow investigation of the relationship between weather events and demographic variables.

IMPROVING THE REPORTING OF MASS MORTALITY (WRECK) EVENTS OF SEABIRDS

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There is an absence of quantitative criteria and definitions for unusual or anomalous mortality events involving birds, often referred to as 'wrecks'. These events most commonly involve seabirds, although terrestrial bird wrecks have also been documented. Typically, the peer-reviewed literature investigating wreck events lacks the detail necessary to further our understanding of the circumstances and potential causes of these events. This study reviewed the peer-reviewed literature for wrecks involving *Ardenna* seabirds, and also included grey literature as well as data collected by citizen science (community)

groups. Our results showed a significant time-lag in the peer-reviewed literature between wreck events and when the data was published, which did not occur in the grey literature. Both the grey and peer-reviewed literature were often skewed towards larger wreck events, with only the citizen science dataset capturing smaller wrecks. Here, we outline a new approach for reporting mortality events, including the use of quantitative categories to document numbers of birds involved and taxon-specific thresholds. In doing so, we aim to establish a framework to aid in the quantitative analyses of future seabird wrecks.

IMPROVING UNDERSTANDING OF TROPHIC LINKS AND INDIVIDUAL-LEVEL MOVEMENT AND HABITAT USE OF NON-BREEDING NORTHERN GANNETS

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Marine ecosystems are complex, with interconnected natural and anthropogenic drivers influencing spatiotemporal patterns of marine predators. Resource availability is a key factor driving seabird movements and distributions, but information on prey availability is difficult to obtain at useful scales for understanding predator ecology. Novel techniques combining digital aerial survey data that capture the location and size of surface-level forage fish shoals with bottom trawl survey data may provide prey information relevant to the spatiotemporal movement and distribution of seabirds. This study aims to explore trophic links between seabirds and their prey base, examining the movements of Northern Gannets (*Morus bassanus*) in the U.S. Atlantic during the non-breeding season. Using satellite telemetry data from adult and juvenile Northern Gannets (n = 75), we employed hidden Markov models to examine behavior states in relation to environmental covariates (e.g., sea surface temperature, depth) and forage fish availability. This analytical framework examines the degree to which forage fish surface shoal data improves our understanding of the movement behavior of Northern Gannets. Our results suggest that individual-level variation plays an important role in behavioral states, and that dynamic covariates associated with prey availability are likely more important than static covariates, such as depth and distance to shore. Disentangling trophic relationships is critical to understanding the mechanisms driving seabird behavior and space use and in turn understanding how future changes to marine ecosystems via climate change and offshore wind energy development can impact seabirds through direct and indirect pathways.

LIGHT IMPACTS ON THE THREATENED SEABIRD COMMUNITY OF THE JUAN FERNÁNDEZ ISLANDS, CHILE

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The impacts of light pollution on seabirds have been increasingly well documented, with the threat being greatest to nocturnal burrow-nesting species. Light-induced fallout, or grounding, can result in injury or death directly due to collisions with human-made structures or indirectly through predation, vehicle collisions and/or dehydration or starvation. The breeding seabird community of the Juan

Fernández Islands, Chile is comprised of six species, four of which are Chilean endemics and are globally listed as Vulnerable. Of the multiple threats confronting the species, light attraction on both of the main islands, Robinson Crusoe and Alejandro Selkirk, historically has been a minor but chronic issue. We have monitored light-induced seabird fallout in the town of San Juan Bautista on Robinson Crusoe annually since 2012, with the number of grounded birds consistent between 2012-2019 (range of 25-68 birds per year, primarily fledgling Pink-footed Shearwaters *Ardenna creatopus*). Of those grounded birds, 59% were found alive and were released. However, following the completion of a major new shoreline infrastructure project in early 2020, seabird fallout increased dramatically to 169 individuals, with significantly lower survival rates (43%). Oikonos is working with the local municipality and government agencies to address this issue. We also conduct a seabird rescue program in the community, with residents reporting grounded birds to local Oikonos staff for identification, assessment and, for healthy birds, release. Since its inception, this program has raised awareness of light attraction issues in the community, encouraged active participation in a conservation activity, and rescued hundreds of grounded seabirds.

SEABIRDAWARE: A TOOL FOR COMMUNITY SCIENCE BASED SEABIRD MONITORING

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Interest in local seabird populations and the issues surrounding them drives community science groups to action. One of these issues is disturbance to roosting and breeding seabirds in popular coastal locations. However, community groups may be uncertain how to organize and conduct surveys, or how to share their observations with land managers or agencies. Enter SeabirdAware, a tool we are developing for use by community scientists who want to know more about and protect their local seabird populations. SeabirdAware is a collaborative, group-based program that utilizes methodology developed during the baseline California Marine Life Protection Act seabird surveys. Protocols, data entry apps, and visualization of data including graphs and distribution maps are available via a website. The site is a repository for scientific information, outreach materials, and data that can be utilized by community scientists and resource managers to improve messaging to local ocean user groups. Organized, standardized community science efforts that record detailed information on seabird habitat use and location-specific sources of human-caused disturbance allow resource managers to focus outreach messages to targeted audiences. Currently two community science groups are participating in this effort, and have provided data that has enabled educators and interpreters to teach coastal visitors about local seabirds and how to avoid disturbing them while recreating.

EFFECT OF MARINE ANTHROPOGENIC ACTIVITIES ON THE BEHAVIOUR OF *SPHENISCUS HUMBOLDTI* DURING THE NON-BREEDING SEASON IN PERU

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Unregulated recreational activities may have potential adverse effects in wildlife. Penguins in some regions have experienced disturbance by visitors in their colonies that stressed physiological, reproductive and population changes. Around some Peruvian guano islands, anthropic marine activities such as tourism and fishing exist and are not well-regulated. We studied the changes in behavioral response of Humboldt penguin (*Spheniscus humboldti*) in relation to tourist and artisanal fishing activities around *Islas* Asia and Pachacamac in central Peru. We aim to (a) assess the behavioral response of loafing penguins on the shore to five marine human activities: line fishing, diving compressor fishing, tour boats, jet skiing and kayaking to approach distances (100, 80, 50 and 30m) and (b) examine whether any penguin reaction was related with group size of colony. Our results showed that the reaction of penguins was activity-specific, with jet skiing having the major effect in leading the penguins to flee to the sea. There was also an inverse relation between penguin reaction to disturbance and the distance of the disturbance source. Our results will be helpful to authorities and managers of the islands to establish bans and protocols to reduce disturbance on the Humboldt penguin colonies.

DIET FROM DEEP-SEA -UTILIZATION OF MESOPELAGIC MICRONECTON BY BLACK-TAILED GULL

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The black-tailed gull *Larus crassirostris* is a coastal related, diurnal surface-fishing gull, that breeds in the Far East region and especially in Japan. Previous study revealed that black-tailed gulls forage manly on pelagic fish species such as anchovy, sardine and sandlance. In this study, however, we found substantial usage of the deep-sea living mesopelagic micronekton species from the diet of black-tailed gulls. We collected the stomach contents of Black-tailed gulls from two islands in the Tohoku region(Nisai Island, Iwate Prefecture, and Benten Island, Aomori Prefecture, Japan) in June and July, 2019. We conducted conventional stomach content analysis and DNA analysis for detailed species identification for the samples. We also obtained GPS tracks from breeding Black-tailed gulls (N=6) simultaneously on Nisai Island. Though the major prey species of the gulls in both islands were Japanese sardines *Sardinops melanostictus* (IRI: 38% in Nisai Island, 90% in Benten Island), the second most prevalent diet species was mesopelagic micronekton species such as garnet lanternfish *Stenobrachius nannochir*, spotted barracudina *Arctozenus risso*, deep-sea shrimp *Bentheogennemα borealis* and mesopelagic living squid *Eogonatus tinro*, especially on Nisai Island (IRI: 37%). GPS tracks reviled that the gulls conducted trips not only to the coastal area, but also far pelagic areas ranging from 1000-3000m in bathymetric depth. The tracks also revealed their substantial amount of night time trips during the study period. Those behavioral characteristics might be closely related to their mesopelagic micronekton use. Further investigation for ecological significance of utilization of mesopelagic micronekton by coastal seabirds is needed.

PERIODS OF HIGH RECRUITMENT BUFFER AGAINST POPULATION DECLINE OF CASSIN'S AUKLETS (*PTYCHORAMPHUS ALEUTICUS*) ON THE SOUTHEAST FARALLON ISLAND

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Mark recapture studies provide an opportunity to assess the relative contribution of survival and recruitment to population change. For long-lived species, natural selection generally favors high adult survival and a flexible approach to reproduction, where individuals capitalize on favorable years by maximizing fecundity, but skip reproduction during years when conditions are less ideal. Double brooding, whereby two broods are reared to fledging in a single breeding season, is a strategy used in some avian species to maximize fecundity. Cassin's auklets are one of a few seabird species where double brooding is common. We used Pradel temporal symmetry models to evaluate whether patterns of recruitment were linked to biological and environmental conditions. Periodic peaks in recruitment rates were explained by a reduction in competition for available nest sites, and an interaction between the proportion of the population that attempted double brooding four years prior and spring upwelling intensity in the current year. Derived estimates of population change using the best supported Pradel model and those made from long-term index plot counts indicated the Farallon population of Cassin's auklets has remained relatively stable over the past three decades. We demonstrate that this stability was likely attributable to a "floating population" of non-breeding adults, which recruited into open nest sites left behind after periods of below-average adult survival. These results highlight the importance of double brooding, whether it be from environmentally driven changes in fecundity or a result of the contributions of higher quality individuals, in maintaining the population of a long-lived seabird exposed to variable oceanic conditions.

WHO IS SUSCEPTIBLE AND WHO IS SAFE? USING AT-SEA DENSITY AND OCEAN CIRCULATION MODELLING TO ASSESS VULNERABILITY OF MARINE BIRDS TO OILING

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One of the more spectacular forms of marine pollution is oiling, often exemplified by seabirds. During any spill, the likelihood of a taxon succumbing is dependent on the likelihood that a bird can/will avoid oil, the extent of the spill, oil spread and persistence, and the prevailing weather and surface circulation conditions. In this study, we combine spill report data, simulations of carcass dispersal from an ocean circulation model, and at-sea distribution of six seabird taxa to model relative estimates of species susceptibility, which we compare against actual carcass counts. The *Tenyo Maru* oil spill occurred in '91 ~20 miles northwest of Cape Flattery on the Olympic peninsula in Washington state, USA. The spill path spanned the Washington coast, with oil detected as far south as Lincoln City, OR. Wildlife and coastal impacts were most prominent along the northern Olympic peninsula; 4,300 oiled bird carcasses were collected. Across all model runs, maximum oil exposure (geo-specific oil risk × at-sea density) was overall

highest for Common Murres (*Uria aalge*). Northern Fulmars (*Fulmarus glacialis*), Common Murres and Tufted Puffins (*Fratercula cirrhata*) had the highest relative susceptibility scores. Parsing the spill into independently-assessed time windows was the most sensitive parameter inflating oiled carcass deposition, followed by degree of dispersal. Using a time-dependent approach accounting for previously killed birds, and allowing oil dispersal, produced beaching estimates between 4% and ~17% of actual counts, by taxon. Relative differences in carcass occurrence were most pronounced for Sooty Shearwaters (*Ardenna grisea*), which represented a much lower than predicted proportion of the actual carcass count.

DIVERGENT POSTBREEDING SPATIAL PATTERNS OF SYMPATRIC ALBATROSS SPECIES IN THE NORTH PACIFIC

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Understanding the at-sea movements of wide-ranging seabird species is essential for conservation and management efforts. Laysan (*Phoebastria immutabilis*) and black-footed albatross (*P. nigripes*) face heightened mortality during the nonbreeding phase of their annual cycle, particularly due to incidental by-catch in fisheries. Habitat use of these species during the breeding period is well-described; however, distributions during this critical nonbreeding period are less understood. Improved understanding of albatross distributions during the nonbreeding phase may provide insights into drivers of foraging behavior and habitat use. Between 2008-2012, we deployed geolocation devices on Laysan (n=81) and black-footed albatrosses (n=58) from two colonies in the northwestern Hawaiian Islands - Midway Atoll and Tern Island, French Frigate Shoals. Location estimates derived using a probabilistic algorithm were used to characterize at-sea distributions. We generated kernel density estimates from modeled locations and defined habitat use using the 95th density contour. Utilization distribution overlap indices of the 95th contour were compared between species, years, and colonies. Trip characteristics of nonbreeding migrations differed between species and colonies, and we found interspecies spatial segregation to persist into the nonbreeding phase both within and between colonies. Population-level metrics such as the degree of overlap between the two species and geographic patterns of space-use showed low consistency across years. This preliminary work will increase our understanding of the spatial patterns and habitat use of Laysan and black-footed albatross during a critical, but often overlooked, phase in their annual cycle.

PRINCE WILLIAM SOUND MARINE BIRD POPULATION TRENDS: 1989-2018

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The waters and shorelines of Prince William Sound (PWS) provide important feeding, resting, and breeding sites for many marine birds. In 1989, the T/V *Exxon Valdez* grounded on Bligh Reef in the northeastern corner of PWS and spilled 40 million liters of crude oil into the surrounding waters. Direct mortality to marine birds in PWS and the Gulf of Alaska was estimated at approximately 250,000 birds.

Since the *Exxon Valdez* oil spill (EVOS), 15 summer (July) surveys over a 30-year period have monitored population trends of marine birds in PWS. These surveys are the primary means to determine whether populations injured by the spill are recovering. Data collected from 1989 to 2018 indicated that pigeon guillemots (*Cepphus columba*), marbled murrelets (*Brachyramphus marmoratus*), Kittlitz's murrelets (*B. brevirostris*) are exhibiting long-term declines in PWS. Black-legged kittiwake (*Rissa tridactyla*) densities have also declined in PWS at the same time that nearly complete breeding failures were observed (2016-2018). In 2021, we will continue to explore the hypothesis that climate variability has differentially affected nearshore and offshore components of PWS food webs, and how this may have contributed to the failure of some taxa to recover from the population injury caused by the EVOS.

SEABIRD MONITORING WITH TIME-LAPSE CAMERAS DURING A PANDEMIC

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Time-lapse photography has long been pursued as a method of seabird monitoring in remote locations. Through the decades, complexity and quirks, mechanical and electrical, of cameras, controllers, and batteries have thwarted consistent operation. However, recent advances in all the components of a time-lapse system greatly improve reliability. Several of these systems are used for annually monitoring seabird colony activity at East Amatuli Island, Alaska. Initiated to overcome terrain challenges of in-person observation at this location, automated imaging of cliff- and burrow-nesting seabirds provided additional advantage during the COVID-19 pandemic. The annual field-camp stay was cancelled, but the nine cameras photographed cliff and burrow habitat every 90 minutes through the nesting season. From these images we determine common murre (*Uria aalge*) and black-legged kittiwake (*Rissa tridactyla*) nest attendance; laying, hatching, and fledging dates; and chick counts. For tufted puffins (*Fratercula cirrhata*), periodic counts from images of birds near their burrows are being used as indices of puffin population trend and possibly reproductive effort and output--development of these methods continues.

THE USE OF THERMAL IMAGING FOR THE CENSUSING OF COLONIAL SEABIRDS IN THE GULF OF ALASKA: IMPLICATIONS FOR MANAGEMENT AND CONSERVATION

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Seabirds are important bioindicators of overall ecosystem health as they rely on marine resources for their survival and can be monitored far easier than aquatic organisms. Given seabirds' critical role in determining coastal and pelagic conditions, it is imperative that we be able to accurately assess their breeding success and population fluctuations over time. This study investigates how infrared (IR) technology can be paired with traditional digital photography methods of censusing colonial seabirds to increase the accuracy of population counts. Boat-based surveys were conducted bi-weekly during the breeding season in 2018 and 2019 to collect thermal data of colonial seabirds in the Chiswell Islands of the Alaska Maritime NWR using a thermal imager with a visual light camera module (FLUKE Ti50). Images

were collected of seabirds utilizing diverse substrates, such as rock, vegetation, and water, in contrasting weather conditions, with study species encompassing alcids, gulls, and cormorants. The thermal and visual images collected at each site were used to generate seabird counts, then compared to determine differences in efficacy between these two censusing methods. IR technology proved useful in detecting species with visually cryptic plumage that easily camouflage to their surroundings. Additionally, IR technology improved the detection of species that roost in areas with low light levels, such as caves, which are typically not visible to surveyors. This study provides researchers with best-practice techniques when applying IR technology to seabird censusing to improve conservation and management practices.

SHORT-TAILED SHEARWATER TIMING AND MOVEMENT THROUGH ALASKA'S SEAS, BASED ON AT-SEA SURVEYS, 2007-2019

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Short-tailed shearwaters (*Ardenna tenuirostris*) make an annual migration from breeding sites in Australia to rich foraging grounds in Alaska. The Alaska portion of this ~ 30,000 km round trip covers four Large Marine Ecosystems and occurs primarily from May to September. Based on >250,00 km of at-sea surveys in Alaska (2007-2019), shearwaters reach the Gulf of Alaska by late April/early May, and by mid-May they aggregate in Aleutian passes. During late June they disperse northward across the Bering Sea and by July they funnel through Bering Strait into the Chukchi Sea. From mid-August to mid-September, large numbers forage in the Chukchi Sea, with some reaching as far as 74.5° North. Others round Nuvuk (Pt. Barrow) to feed in the western Beaufort Sea. Few birds lingered in October before returning south. Shearwaters travel to Alaska to feed on small fish, squid, and krill (euphausiids), and can comprise 50-78% of total seabirds encountered, depending on location and time period. Our surveys indicate that shearwaters have increased in the Chukchi Sea, particularly during the exceptionally warm years of 2017-2019. Mean densities of shearwaters during these three years ranged from 1.3 birds/km^2 in the Bering Sea to 11.5 birds/km^2 in the northern Chukchi Sea, with some 30-km grid cell means of >150 birds/km^2. Over the last decade open-water season in the Chukchi Sea has increased dramatically, leading to higher biomass of zooplankton during late summer, and likely fueling the shearwater's northward advance.

THE PARALLEL ADVENTURES OF SHORT-TAILED SHEARWATERS AND A CROSS-HEMISPHERIC ART PROJECT IN THE YEAR OF COVID-19

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Every year, short-tailed shearwaters (*Ardenna tenuirostris*) fly from breeding sites in Australia to rich foraging grounds in Alaska - a round trip of ~ 30,000 km. Australian artist Lindy asked Alaskan biologist Kathy if she'd help with a symbolic replicate of the shearwater journey, as neither biologist nor artist could travel in 2020. Lindy produced 10 lino prints of the birds (appropriately masked) and sent them via snail mail to Anchorage. Also in April, the 600,000 shearwaters of Phillip Island (Lindy's home, latitude 38.5° South), paid no heed to travel restrictions and were on their way. Like the birds, the cards took a harrowing six weeks to travel each way, with backtracks and diversions due to insufficient

resources/postage. Similarly, not all of the cards made it back to Australia, and those that did were late, well worn, and heavily stamped. We present Lindy's original artwork, images of the well-traveled cards, and maps showing the movements of short-tailed shearwaters in Alaska. The at-sea surveys, conducted from 2007 to 2019, follow the northernmost portion of the shearwater's journey as they travel through the Gulf of Alaska, the Bering Sea, and the Chukchi Sea, from late April to September, with some reaching as far as 74.5° North. The well-traveled cards and at-sea observations illustrate parallel journeys linking hemispheres, and a collaboration of art and science. The prints are part of 'The Overwintering Project', live in Tasmania (2020) and Victoria (2021).

THE SEABIRD OBSERVER NOTES: 26-YEAR OVERVIEW OF SEABIRD RELATED OBSERVATIONS INCLUDING VESSEL STRIKES IN ALASKA GROUNDFISH FISHERIES 1993-2019

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The Seabird Observer Notes (SON) were instituted in 1993 by the NOAA Fisheries Observer Program to record opportunistic seabird observations made by NOAA observers in Alaskan Groundfish Fisheries. The SON is a cooperative effort between the U.S. Fish and Wildlife Service and NOAA Fisheries to improve accessibility to the seabird information collected by fishery observers. Initial observations were handwritten on datasheets in the field, and later transcribed into a searchable database format. In 2010 NOAA developed an automated data entry system where the SON could be electronically entered in the field by the observer and sent back to the Observer Program in Seattle. The SON records information such as seabird species, date, location, weather, and interactions between seabirds and fishing vessels. The information is a valuable resource to identify seabird-fishery related issues including gear interactions, discard feeding, rare bird sightings, mapping seasonal distribution of seabirds near vessels, and vessel strikes. The issue of seabird vessel strikes is an unattested potential source of seabird mortality in the Alaska Groundfish Fisheries. Seabirds can be attracted to a fishing vessel for a variety of reasons causing them to potentially become disoriented and strike the vessel. The information from the SON can provide an index regarding fishery, spatial, and temporal aspects of these vessel strike events and help identify possible mitigation measures. Data archived in the SON is under the purview of the Magnuson-Stevens Act, and release of data or products requires review by NOAA to protect confidentially agreements with fishers.

ADAPTING SEABIRD BOAT SURVEYS TO ADDRESS BOTH CORONA VIRUS SAFETY AND CHANGING MARINE CONDITIONS

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After a two-month halt to surveys due to the COVID-19 Pandemic, we reconfigured our 8-meter boat and reduced our on-boat team from four to three to reduce transmission risk. Roles that rotated

previously became fixed and included the boat captain who was the only person entering the cabin, operating the boat and coordinating all communications. Observer positions changed from two aft of the cabin to only one observer aft and one observer in the bow who could enter the v-birth via the forward hatch. A new bulkhead was created between the bow and the main cabin to maintain separation. The forward observer ran our data collection program (now collecting only boat position data) in the bow. The field team communicated by wireless Bluetooth headsets that were integrated through satellite or cell phone with the person at home who entered observation data in real-time.
In September, we moved to open ocean conditions where it was unsafe to have someone on the foredeck. We moved both observers back aft of the cabin and installed a plexiglass divider that produced a physical barrier between observers. For winter surveys, we moved back to protected Salish Sea waters with one observer back in the v-birth and we built an insulated and heated booth on the starboard back deck to provide a dry and warm place for the back observer to warm up in during cold, wet winter conditions.
To combine bird observation and boat track log data, we wrote a script in R programmer to combine these datasets using timestamps in both files. By modifying our boat structurally, changing the number of people on the boat, and employing technology, we have been able to complete our contracts and maintain historical data quality while remaining safe.

COMPARISON OF MERCURY LEVELS IN FEATHERS OF OSPREY IN THE NORTHEAST REGION OF JAPAN

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Mercury (Hg) is an environmental pollutant derived from natural and anthropogenic sources and known to bioaccumulate within aquatic food chains. Relying on a diet of mostly fish, osprey (*Pandion haliaetus)* are apex predators and have the highest levels of biomagnification, making them an excellent indicator species for analyzing Hg levels. To compare the total mercury concentration in osprey of the northeast region of Japan, feathers were collected from within the nest and the ground near the nesting sites of Akita (N = 1) and Miyagi Prefectures (N = 8). Feather samples were collected in Kesenuma, Miyagi and Yuzawa, Akita from July to August of 2019 and Iwanuma, Miyagi and Sendai, Miyagi from July to October of 2020. Down feathers had Hg concentrations ranging from 0.56 to 2.52 μg/g with an average of 1.36 ± 0.83 μg/g (mean ± SD). Secondary feathers ranged from 2.74 to 6.05 μg/g with an average of 4.32 ± 1.78 μg/g. Tail feathers ranged from 4.08 to 15.72 μg/g with an average of 7.97 ± 6.71 μg/g. Convert feathers ranged from 0.96 to 34.85 μg/g with an average of 9.38 ± 9.39 μg/g. Our results indicate that Hg concentrations varied between closely located nests and between feather types. We will be examining the relation between feather type and nest location with the total mercury concentration. Despite high Hg emissions in Asia, studies of Hg concentrations in ospreys of Asia are few; we will also discuss the Hg concentrations from other regions (North America, Europe, Asia).

MODELING AT-SEA DENSITY OF MARINE BIRDS ON THE U.S. PACIFIC OUTER CONTINENTAL SHELF

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We report on a multi-year effort to characterize the at-sea spatial distributions of marine birds on the U.S. Pacific Outer Continental Shelf (OCS). Results of this study will inform spatial planning and risk assessment for marine renewable energy in the region. We developed seasonal habitat-based spatial models of the at-sea distribution for 33 individual species and 13 taxonomic groupings of marine birds throughout the U.S. Pacific OCS. A statistical modeling framework was used to estimate relationships between bird sighting data and a range of temporal (e.g., Pacific Decadal Oscillation index), spatially static (e.g., depth), and spatially dynamic (e.g., chlorophyll concentration) environmental variables. The estimated relationships were then used to predict the long-term average spatial density patterns for each species/group throughout the study region in each of four seasons (i.e., spring, summer, fall, and winter). Marine bird sighting data came from several scientific survey programs and consisted of at-sea counts of birds collected between 1980 and 2017 using boat-based and fixed-wing aerial transect survey methods. Spatial environmental variables were derived from remote sensing satellite data and an ocean dynamics model. We present results for example species and discuss how the information can be used to aid marine spatial planning and renewable energy decision processes.

SHIFTING PREY BIOMASS INFLUENCES FORAGING BEHAVIOR AND BODY CONDITION OF CHICK-REARING RAZORBILLS IN COASTAL NEWFOUNDLAND

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During the breeding season, seabirds may respond to shifts in prey regimes, which can lead to changes in foraging behavior and breeding success. In coastal Newfoundland, marine predators, including seabirds, rely on capelin (*Mallotus villosus*), a forage fish that migrates into coastal areas during the summer to spawn. With increasing variability in ocean climate, however, predictability of this important resource has become highly variable, which in turn may influence breeding seabirds. We explored how chick-rearing razorbills (*Alca torda*) respond to interannual resource variability by integrating colony-based measures of body condition, ship-based measures of capelin biomass and device-based foraging

trip and dive metrics from GPS and TDRs during 2017, 2019 and 2020. During 2020, peak capelin biomass was lower and later relative to 2017 and 2019. Within-season increases in prey biomass resulted in reduced foraging trip distance in 2019 (before: 54.1 ± 6.8 km; after: 14.3 ± 1.7 km), but this was not observed during 2020 (before: 122.3 ± 20.4 km; after: 142.4 ± 25.0 km). During years of higher capelin biomass (2017, 2019), razorbills had higher dietary proportions of capelin relative to 2020, which was associated with higher adult body condition (2017: 3.46 ± 0.04 g/mm, 2019: 3.54 ± 0.07 g/mm, 2020: 3.38 ± 0.07 g/mm) and chick condition (2017: 2.89 ± 0.10 g/mm, 2019: 2.95 ± 0.15 g/mm, 2020: 2.45 ± 0.06 g/mm). Findings suggest that continued variability in the timing and biomass of capelin in coastal areas can lead to increased energy expenditure and reduced body condition, which can have long-term population-level consequences in both adult survival and reproductive success.

ASSOCIATIONS AMONG MASS MORTALITY EVENTS, SEABIRD DEMOGRAPHY, AND OCEAN CLIMATE TRENDS IN CENTRAL CALIFORNIA

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Ocean anomalies and El Niño events have led to several major seabird die-offs along the California coast in the past two decades. Understanding what drives these mortality events is difficult. Point Blue Conservation Science, NOAA's Greater Farallones National Marine Sanctuary, and Greater Farallones Association (GFA) have unique long-term datasets on population and productivity of locally breeding seabirds, as well as carcass deposition data collected by NOAA's Beach Watch Program along the central and northern California coast. We integrated and analyzed these data sets to better understand how beached dead birds relate to local breeding populations. We used negative binomial regression models to analyze carcass count (dependent variable) in relation to basin- and local-scale oceanographic variables, climate indices, prey availability, and seabird demography for each species. We analyzed three seabird species that breed in the Gulf of the Farallones and that experienced major mortality events: Cassin's auklet (*Ptychoramphus aleuticus*; mortality events in 2005, 2014), Brandt's cormorant (*Phalacrocorax penicillatus*; 2009), and common murre (*Uria aalge*; 2015). We found significant relationships between carcass deposition of all three species and decreased or delayed local upwelling. Carcass deposition rates increased during periods of warm ocean temperatures associated with El Niño for all age classes. While both prey availability and demographic variables were by themselves significantly associated with mortality events, they were not significant once oceanographic and climate variables were included. For these three species, mortality as indicated by carcass deposition was primarily driven by environmental factors independent of demographic parameters at the colony.

SEASONAL LIFE-STAGE AND MARINE HEATWAVE AFFECT MOVEMENT PATTERNS AND HABITAT-USE OF COMMON MURRES

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Understanding seasonal movements and spatial use of marine predators during anomalous conditions can help understand predator response and delineate important marine areas during times of abundant versus limited resource availability. We tracked common murres (*Uria aalge*) using satellite transmitters during five years with moderate to poor ocean conditions in the California Current System (CCS). We quantified seasonal (summer and fall) differences in at-sea space-use and environmental conditions associated with movement behavior. Murres that engaged in central-place foraging had uncharacteristically large foraging ranges (≤234 km), indicating reduced local food availability. During the breeding period, non-central-place foragers dispersed widely with concentrated use in the Salish Sea and nearshore waters off central and southern Washington, including the Columbia River plume. During fall and coinciding with feather molt, murres traveled rapidly northward to occupy these same regions, with the addition of southern British Columbia. Additionally, two individuals traveled to the Gulf of Alaska during heatwave conditions. Central place foragers engaged in localized movement associated with foraging in both shallow and deep waters with increased salinity. Localized movement of non-central-place foragers increased during the heatwave conditions of 2015, when birds were closer to shore, and during crepuscular periods. Murres dispersing during fall exhibited localized movements in water masses associated with warm sea surface temperature, and in areas with upwelling and low salinity. We identified important areas in the northern CCS during years with varying ocean conditions, including a marine heatwave, and during the flightless molt period; these regions likely sustain northern CCS murre populations during poor conditions.

NONRANDOM SPATIAL DISTRIBUTION OF NEOTROPIC CORMORANTS (*PHALACROCORAX BRASILIANUS*) ALONG A COASTAL HIGHWAY IN LIMA, PERU

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Neotropic Cormorants (*Phalacrocorax brasilianus*) are common seabirds along the Peruvian coast. They frequently perch on trees, poles, and port structures in urban areas, causing discomfort and esthetic

problems due to the dropping of their feces on infrastructure and people. Hundreds of these birds rest on lighting poles and telephone cables along a 12.7 km highway in the coastal strip of the city of Lima, Peru. We hypothesized that the distribution of the cormorants along this highway is clustered and could be associated with physical features of the coast. Half-monthly or monthly cormorant counts per lighting pole and adjacent telephone cables (pole-cable) were performed from July 2018 to March 2020 at four count hours (0600 h, 1000 h, 1400 h, and 1800 h). Our results revealed that daily bird numbers varied from 46 to 457 individuals and that only 17% of the total number of pole-cables (N = 651) was occupied once by at least one individual. The number of cormorants also varied between count hours within the same day (higher numbers at 1000 h and 1400 h). Birds were clustered into a maximum of five hotspots along the highway. According to the Akaike's information-theoretic approach applied to Poisson GLMM, higher numbers of cormorants on pole-cables were associated mainly with a closer distance from these structures to the shoreline and to the surf zone, suggesting that Neotropic Cormorants may select such pole-cables as optimal sites for sighting and receiving clues of prey availability. Based on the results, the use of nonlethal deterrents and the relocation of these birds to other perching structures on nearby groynes could be the most suitable and eco-friendly solution for the problems caused by their droppings.

LIGHTING ADJUSTMENTS TO MITIGATE AGAINST DECK STRIKES/VESSEL IMPACTS

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Artificial light at night (ALAN) can negatively impact nocturnally active seabirds by causing disorientation, exhaustion, injury and/or mortality from collisions. The Hauraki Gulf in Aotearoa/New Zealand has one of the world's highest diversities of seabirds, many of them vulnerable to light pollution, including threatened seabird species. While most of these species breed on offshore islands, the extensive shipping activity in this region puts seabirds at great risk of collisions with vessels. This study, undertaken on two seabird islands, tested which light intensities and colours were least attractive to seabirds through behavioral experiments by projecting lights into the sky and recording the attraction. We also modeled the lights into the visual system of seabirds to identify how seabirds perceive lights differently. Our experiments showed an equal statistical attraction to the light types we tested, but provided anecdotal observations of where more research and larger sample sizes are required. The number of seabirds trapped in the light beam differed by island and moon phase. Most of the seabirds grounded occurred on Pokohinu/Burgess Island during the flood LED treatment. Differences between islands likely reflected the local seabird diversity at each island. Future vessel-based and further land-based behavioral experiments should incorporate a greater range of moon phases and increasing the sample sizes for each lighting treatment.

FLEXIBILITY WINS OUT: PROJECT PUFFIN IN THE YEAR OF COVID-19

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Audubon's Seabird Institute (aka "Project Puffin") cooperatively manages a network of 7 seabird islands along the coast of Maine, USA, where we conduct stewardship, monitoring, and research. Island work has occurred largely uninterrupted for several decades on a diverse seabird community including 4 species each of alcids and terns, among others. Our ongoing tasks include protecting seabirds from predators, human disturbance, and the encroachment of invasive vegetation, along with collecting data on abundance, productivity, diet, demography, and other traits. We were able to deploy seasonal biologists on all 7 islands in 2020, although staffing levels were reduced, and successfully completed a majority of our normal work without any incidence of Covid-19. We revised normal protocols in multiple ways to enhance the safety of seasonal and permanent staff, including modifications such as: (1) island staff were isolated on their respective islands for the entire season without leave to the mainland; (2) movement of permanent staff between the mainland and islands was reduced, including resupply trip frequency; (3) island visits by research collaborators, international fellows, journalists, educational programs, and supporters were eliminated; and (4) traditional large-group, in-person staff training was cancelled and replaced with minimal small-group, socially-distanced, in-person, outdoor training and written documentation supplemented by phone conversations. Our planning and safety protocol design benefitted greatly by close communication with our management partners the US Fish and Wildlife Service and Maine Department of Inland Fisheries and Wildlife.

PROVISIONING BEHAVIOR AND KLEPTOPARASITISM RISK IN RHINOCEROS AUKLETS

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We examined the provisioning behavior and chick growth of rhinoceros auklets (*Cerorhinca monocerata*) in a breeding colony on Año Nuevo Island off the California Central Coast. We set up six infra-red cameras adjacent to auklet burrows to record all nocturnal visits during the chick rearing period (1-5 weeks of footage for each burrow). We counted all non-feeding visits, feeding visits, number of fish in each bill load, and kleptoparasitism events by western gulls (*Larus occidentalis*) recorded at each burrow and compared those to chick growth. We found that feeding rate and size of bill loads was not an accurate predictor of chick growth rate or final weight before fledging. Burrows experienced varying degrees of pressure from kleptoparasitism by gulls (0%-50% of all feeding trips). Provisioning adults who experienced high kleptoparasitism rates may compensate with higher numbers of feeding trips; a higher kleptoparasitism rate did not negatively impact chick growth.

FORAGING OF BLACK-TAILED GULLS DETERMINED BY GPS POSITION AND BODY ACCELERATION

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Identifying the areas where seabirds forage intensively and so prey density could be high helps conservation of seabirds and for ecosystem-based fishery managements. However, the locations of foraging could not be determined precisely only by the track and moving speed. Body acceleration informs various types of foraging behavior. Our aims were to classify foraging behaviours of surface feeding seabirds with body acceleration and find areas where these were conducted. We first video-taped Black-tailed Gulls (*Larus crassirostris*) for references, then tracked and recorded their movement using GPS loggers and accelerometers on 7 and 10 birds in 2017 and 2018, respectively. Flying (flapping, gliding, and hovering), foraging (plunging, hydroplaning, and swimming/surface seizing) and maintenance and resting behaviours can be classified using the speed, the body angle and the cycle and amplitude of body acceleration. Areas where birds were conducting foraging coincided with the areas of locations of low-speed locations and area restricted search that can be determined GPS location only. This study showed that the body acceleration data gives useful information for determining the foraging area of this species precisely.

PREDATION PRESSURE DISRUPTS COMMON MURRE BREEDING SUCCESS IN KACHEMAK BAY, ALASKA FOLLOWING THE NORTH PACIFIC MARINE HEATWAVE

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The Common Murre (*Uria aalge*) is a colonially nesting seabird whose breeding success can be influenced by predation pressure and prey availability. Following the North Pacific Marine Heatwave and unprecedented die-off in 2015-2016, we resumed annual monitoring of Common Murres at Gull Island in Kachemak Bay, Alaska, for comparison with baseline data from the late 1990's. After observing complete reproductive failures on productivity plots from 2016 to 2018 (mean±SD: 0.00±0 chicks/pair), in 2019 Common Murres fledged chicks for the first time since the heatwave (0.26 chicks/pair), but at roughly half the rate during 1995-1999 (0.54±0.15 chicks/pair). To quantify predator disturbance as a potential factor influencing breeding success from 2016 to 2019, we used time lapse cameras to monitor the frequency and intensity of predator-induced flushes and rates of direct and facilitated predation over the course of the breeding season. Predator disturbance was observed in all years, but flushes were more frequent and prolonged in 2016-2018 than in 2019. Rates of direct predation on adults by Bald Eagles (*Haliaeetus leucocephalus*) and direct and facilitated predation on eggs by Glaucous-winged (*Larus glaucescens*) and Herring Gulls (*Larus argentatus*) were also higher in 2016-2018 compared with 2019. Associated information on forage fish indicated that high quality prey were more available in the system during 2019 than previous years, which may have contributed to greater synchrony in laying, facilitating resilience to predator disturbance. These results, in addition to continued monitoring of

breeding success in the context of predator disturbance and prey availability, will help us understand Common Murre recovery following the die-off.

A SPATIAL MODEL TO PREDICT WINDMILL COLLISION RISK FOR TWO GULL SPECIES

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To develop offshore wind farms, assessments of the impact on marine wildlife are essential but have not been fully investigated. Mapping the fine scale sensitivity of species of seabirds is required most urgently, especially in Japan. To explore environmental factors that increase the possibility of collision, i.e. flying at altitude of blades (20 - 140m or M-zone), we 3D GPS tracked 117 Black-tailed gulls *Larus crassirostris* and 21 Slaty-backed gull *L. schistisagus* that nested in six colonies in two areas in northern Hokkaido in 2016 - 2019 and constructed a spatial model using random forest at 1km spatial scale. The species, areas and colonies were least important as factors explaining the ranked possibility of collision, though year showed intermediate importance. The importance of the environmental factors was in order of colony distance >the number of fishing ports within 45km > sea depth > distance from the coast line. Birds had the high possibility in 1km cells near the colony, with larger number of fishing ports, shallow sea depth and close to the coastline. Therefore the efficacy of the model is almost independent with the species and colonies. This demonstrates the usefulness of the model for constructing collision risk maps of generalist gull species.

ALEUTIAN TERN NEST ATTENDANCE RATES

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The Aleutian tern (*Onychoprion aleuticus*) is a migratory seabird that nests in Alaska and Eastern Russia. The Alaska breeding population of this species is currently experiencing a large decline due to unknown reasons. Unfortunately, there has been little research on the basic biology of this species, including behavior at the nest site by adult Aleutian terns. We were interested in understanding nest attendance rates of Aleutian terns during incubation. Incubating terns will leave their nests when disturbed, exposing the eggs to the elements and predators such as black-billed magpies (*Pica hudsonia*), northwestern crows (*Corvus caurinus*), and red foxes (*Vulpes vulpes*). Due to this, Aleutian terns may spend relatively different amounts of time at their nests during the night compared to the day, depending upon the sources of disturbance. To investigate nest attendance rates, we used timed nest-view cameras that were placed at 14 nests in the Kodiak Archipelago, Alaska. The cameras were set to capture images of the nest every two minutes. With this data we were able to determine the nest attendance rate of a given nest based on what percentage of the time there was at least one adult

Aleutian tern at the nest. We found that median nest attendance was 80% (23 – 96%) during daylight hours and 86% (0 – 100%) at night. Our analysis did not find a meaningful difference in mean nest attendance between day and night (P = 0.90). Only one of the nests that were studied produced a chick, this nest had a daytime nest attendance rate of 65%, and a nighttime attendance of 76%. These attendance rates were lower than we expected based on other reported attendance rates for tern species during incubation.

A SEABIRD'S EYE VIEW OF ARTIFICIAL LIGHT AND THE MOON

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Artificial lights at night cause high mortality in fledgling seabirds due to attraction and subsequent grounding, particularly during the new moon. Previous studies on migratory birds suggest that the color of artificial light can affect attraction, but the drivers behind this behavioral phenomenon are poorly understood. It is known that the number of grounded fledgling seabirds, such as the Wedge-tailed shearwater (*Ardenna pacifica),* fluctuates with the moon. To investigate visual cues that may be driving observed light attraction behavior, visual contrast models were created using the PAVO R package. Using published data on the visual system of *A. pacifica* and the spectra of common streetlights, we investigated how the color contrast of the moon and artificial lights compare, and how Wedge-tailed shearwater *A. pacifica* perception may differ from human perception. Results suggest humans are more easily able to detect differences in color between artificial lights and the full moon than *A. pacifica*. Results also suggest that to seabirds, many artificial lights look similar in color to the full moon. These results are consistent with behavioral tests of seabird attraction to a variety of common streetlights and have implications for conservation management of artificial light near seabird colonies.

LINKING MERCURY CONCENTRATIONS WITH AT-SEA AREAS IN THREE SPECIES OF AUKS, BREEDING ACROSS THE PACIFIC ANF ATLANTIC OCEANS

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Mercury is a toxic, bioaccumulating trace metal whose emissions have recently been increasing and impacting even remote environments. Seabirds integrate bio-accumulative mercury via food intake. This is mainly deposited during the molting period in which the feathers are replaced annually, and the concentrations reflect the uptake and storage of mercury between molts. By using feathers as bio-

indicators of mercury contamination, we examine variation in marine mercury concentrations in the Pacific and Atlantic Oceans. We collected primary, rectrix and breast feathers in 2019 from three auk species with similar body masses (Rhinoceros Auklets *Cerorhinca monocerata*, Tufted Puffins *Fratercula cirrhata*, Atlantic Puffins *Fratercula arctica*) each subjected to different levels of mercury emissions in the Pacific (Middleton Island, USA; Teuri Island, Japan) and Atlantic (Skomer Island, UK). We measured mercury concentrations, then linked these concentrations with the birds' locations recorded with geolocators. The mean mercury concentrations of rectrix feathers collected in western Pacific and Atlantic in 2019 were slightly higher (1.64 ± 0.48 μg/g of dry weight (dw); n = 19, 1.66 ± 1.74 μg/g (dw); n = 21) than those at northern Pacific in 2019 (1.33 ± 0.21 μg/g (dw); n = 37). We discuss potential factors affecting the levels of mercury burden among different species and locations.

#BARFYSCIENCE: ALBATROSS AS AMBASSADORS FOR CLEAN OCEANS

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Engaging online STEM resources increased in demand when middle and high-school classes transitioned from in-person to virtual during the pandemic. We created the Winged Ambassadors classroom curriculum a decade ago to teach marine pollution and ocean stewardship, through the eyes of seabirds. Black-footed and Laysan Albatrosses guide students through five lessons on seabird biology, migration tracking, ocean hotspots, seabird foraging, and marine debris. Since 2012, the curriculum has reached a minimum of 9,280 educators and 382,280 students in 48 states and 38 countries. In 2020, we adapted the tracking maps, diet datasheets, and other activities for students learning online from home. In addition to a five-part curriculum, we provided over 2,400 albatross boluses collected from Kure Atoll to 395 educators (2008-2020). By dissecting real boluses, students directly experience the threat of human-made trash to seabirds and other marine wildlife and explore the possible sources of this trash. Surveys following the bolus dissections indicated that 96% of educators (n = 149) agreed that they would recommend this engaging activity, which inspired enthusiasm for science. We continue to adapt the program to the changing needs of educators, using ongoing evaluations and assessments, and seek innovative ways to share the world of seabirds with students. Future adaptations include translations of select lessons into Spanish, Hawaiian and Asian languages, and live-streaming dissections with question and answer sessions with researchers.

BIRDS AND DEBRIS: COLLATING DATA ON ENTANGLEMENT AND NEST INCORPORATION OF ANTHROPOGENIC DEBRIS

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Anthropogenic debris is a global environmental issue, which can impact a wide range of species, especially seabirds. Debris (mostly plastics) has affected at least 36% of all seabird species through entanglement – at sea or at the nest, where debris is used as nesting material. However, this largely involves anecdotal reports of entanglement and nest incorporation. Therefore, there are a lack of quantifiable data, on an international scale, to determine how anthropogenic debris affects individuals through entanglement and nest incorporation. This means we currently do not fully understand the full effects that debris may have on individuals and populations. To extract useful information on anecdotal incidents of entanglement and nest incorporation in anthropogenic debris by birds, especially seabirds, we have created a website www.birdsanddebris.com to collate images and descriptions of nest incorporation, and incidences of entanglement, taken ad hoc by researchers and members of the public. From these images and descriptions, we can explore which species are most reported by this issue and where, as well as which types of debris are involved in incidences of entanglement and nest incorporation. Here we present some preliminary results from submissions made globally so far, focusing on seabirds. You can help by uploading information for any bird species, anywhere in the world, for any type of debris (i.e., plastic, metal, glass, fabric) whilst at home or during field work. We hope that enlisting the help of researchers, and the public, will help us to better understand the scale and geographical spread of this issue. We can then use this information to inform policy and future monitoring initiatives.

FORAGING, DIET AND BREEDING OF RHINOCEROS AUKLETS AT TWO COLONIES IN THE DIFFERENT CURRENT SYSTEM

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To understand how ocean current system affects the foraging areas, diet, breeding performance, and adult body condition of Rhinoceros Auklets, we compared those breeding at Teuri Island in the northern Tsushima Current (warm water) and Todo Island (100 km apart) in the northern end of Tsushima Current and relatively close to the cold water in the Sea of Okhotsk (Okhotsk cold water). We collected food-loads, body condition of chicks and adults, fine-scale movement via GPS loggers (only early chick-rearing period) and rough foraging area via temperature data of geolocators throughout the chick-rearing period in 2018-2019. Parents at Todo used Okhotsk cold water, the frontal water between Okhotsk cold water and Tsushima Current Extension warm water or the close coastal Tsushima warm water

throughout the chick-rearing. Parents at Teuri mainly used the southern coastal Tsushima warm water in the early period but they seemed to use also the Okhotsk cold water farther north of the colony in the later period. Parents at Todo fed to chicks mainly greenling and >1sandlance that were abundant in relatively cold water in this region and the energy value of food load was 132-178 kJ/load. Parents at Teuri, however, fed 0+sandlance and greenling and others and the energy value of food-load was lower (104-111 kJ/load). Breeding performance at Todo was better than on Teuri in both years, while the adult condition did not differ. Our inter-colony comparison shows how different ocean current system affects the resource allocation pattern for parent-offspring.

PHOTOGRAMMETRIC MONITORING OF DOUBLE-CRESTED CORMORANTS NESTING SITES ON IRONWORKERS MEMORIAL BRIDGE IN VANCOUVER

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Like many seabirds, cormorants (*Phalacrocorax* spp.) nest and roost colonially on cliffs and offshore islets inaccessible to mammalian predators. In Canadian waters of the Salish Sea, there has been a shift in cormorant use of these natural sites to bridges and hydroelectric towers. Presently, up to half of Double-crested Cormorants (*P. auritus*) nesting in British Columbia do so on urban bridges within the city of Vancouver, an urban centre of 2.5 million people. This has caused conflict with provincial bridge engineers concerned that cormorant nesting may interfere with bridge inspections or that acidic guano may damage infrastructure. Over the last 12 years, exclusionary measures have been implemented and more are proposed to keep bridges free of cormorants. This study investigated the habitat structure and nest site selection on Vancouver's Ironworkers Memorial Bridge, the largest Double-crested Cormorant colony in British Columbia (294 nests). We collected a time series of high-definition panoramic photographs using GigaPan® technology from May to October 2020 to characterize nest sites and habitat use on the different sections of the bridge. Results showed that birds were not uniformly distributed and nest site selection depended on bridge structural characteristics like horizontal lateral bracings. We noted the disappearance of some nests over the nesting season and speculated that these sites provide marginal habitat for Double-crested Cormorants. The spatial-temporal distribution of bridge-nesting cormorants in this study can be used to understand the implications of nest site selection and provide support to encourage coexistence of this at-risk species with bridge management objectives.

SEASONAL CHANGES IN THE SPATIOTEMPORAL EXTENT OF OCEANOGRAPHIC DATA COLLECTED BY CORMORANTS

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Cormorants have high energetic costs of diving, yet each day they dive repeatedly to meet their energetic needs. This high volume of foraging activity suggests that when equipped with biologging devices they could be effective environmental samplers of the nearshore environment where they foraging. This includes benthic dives that can be used as bathymetric sounding. This is particularly relevant in nearshore and estuarine environments where bathymetry is dynamic and hard to measure *in situ*. However a better understanding seasonal changes in daily foraging effort and individual spatiotemporal fidelity to foraging locations would aid in refining sample sizes. In 2019, solar-powered GPS-GSM tags with integrated depth sensors were used to track Brandt's cormorants (*Phalacrocorax penicillatus*) captured and tagged in the Columbia River estuary, Oregon, USA during the summer nesting period. Eight of the individuals that were tracked through fall dispersal travelled north to the Salish Sea and the outer coast of Vancouver Island, B.C., Canada, one individual travelled to the Southern California Coast, and two individuals continued transmitting through Dec 2020, returning to the Columbia River during the summer of 2020. We identified benthic dives and will compare how the frequency of benthic diving changes overtime. Using Brandt's cormorants a biologging network for the US West Coast would generate fine-scale oceanographic data from multiple nearshore environments and important estuaries.

FORAGING AREA SELECTION OF RHINOCEROS AUKLET BREEDING ON BENTEN ISLAND, JAPAN, IN THE TSUGARU STRAIT

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To detect important marine areas for seabirds and to understand the response of marine top predators to the highly fluctuating marine environment, it is necessary to investigate how seabirds select foraging area and marine environment as their preferred habitat. In this study, we obtained GPS tracking data from breeding Rhinoceros auklets *Cererhinca monocerata* in Benten Island, Aomori Prefecture, Japan, located in the Tsugaru Strait (N=3, 28 days and 13 trips in total). Around this island, The Tsushima Warm Current (Sea of Japan), the Tsugaru Warm Current (Tsugaru Strait) and the seasonal front area of the Oyashio Cold Current (Pacific Ocean) are closely located, thus several potential foraging areas characterized by different marine environments, are available for auklets. All individuals used the same area as their foraging site (Pacific Ocean) in all recorded trips. Foraging sites were mostly limited to shallow (<200 m) coastal area. The SST was cooler and the chlorophyll-a concentration was higher in the

foraging area, compare to the surrounding waters, due to the influence of the Oyashio Cold Current. Their food item was assumed to be Japanese sardine *Sardinops melanostictus*. In recent years, a significant decline of the availability of Japanese anchovies *Engraulis japonicus* in the Tsushima Warm Current has been reported, probably associated with a cold regime shift. Our results suggested that the Rhinoceros auklets breeding in Tsugaru Strait respond to the changes in the marine environment by avoiding the Tsugaru Warm Current area and select the cooler, more productive and sardine-rich Pacific Ocean.

CORMORANT OCEANOGRAPHY PROJECT - 2020 UPDATE

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The Cormorant Oceanography Project represents an interdisciplinary collaboration between physical oceanographers, oceanographic numerical modelers, and seabird ecologists. We are developing and deploying dozens of solar-powered, network-connected (GSM) biologging tags to measure in situ environmental conditions along the daily foraging paths of cormorants. Here we present an overview of our recent field deployments, biologging tag developments, analytical methods, and oceanographic modeling integration. In 2020 we deployed solar powered tags on pelagic cormorants (*Phalacrocorax pelagicus*) at Middleton Island in the Gulf of Alaska and on Socotra cormorants (*P. nigrogularis*) in the Arabian Gulf. These deployments provided opportunities to field trial GPS tags with integrated salinity sensors (CTDs), external thermistors, and inertial motion sensors (IMUs) while simultaneously collecting movement ecology data on two cormorant species. We are also refining sampling and analytical methods to estimate surface current speeds from drifting birds (GPS), salinity and temperature profiles from dives (CTD), and surface gravity wave statistics from between-dive surface intervals (IMU). Additionally, we are working with the Animal Telemetry Network to automate data pipelines to deliver oceanographic data in near real-time. These cormorant-derived datasets are then assimilated into coastal ocean models to correct model errors associated with initial conditions by providing in situ measurements and reducing spatiotemporal data gaps. Furthermore, this work highlights the value of interdisciplinary seabird research projects. Biologging projects are collecting animal movement data that can simultaneously advance oceanographic research as well as our understanding of seabird ecology.

EFFECTS OF OPERATING AND PROPOSED OFFSHORE WIND FARMS ON COMMON MURRES (*URIA AALGE*) IN THE SOUTHERN NORTH SEA

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Seabirds thoroughly depend on suitable marine habitats, which are increasingly used for offshore wind farm (OWF) implementation. We investigated how common murres (*Uria aalge*) react to operating OWFs in the southern North Sea, Europe. Based on an extensive dataset, collected by means of visual and digital surveys before and after OWF construction, we detected strong significant effects in spring and in the breeding season. We also deployed GPS-tags on twelve breeding murres to study their individual reaction to OWFs. Murres approached the OWFs when resting or diving, but rarely when commuting. Resource selection of the OWFs was significantly reduced compared with the surroundings and avoidance was stronger, when turbine blades were turning. Applying the detected avoidance values to a long-term dataset on murre distribution in autumn, the season when murre numbers are highest in the study area, we quantified the possible conflict with the planned large-scale implementation of OWFs in German waters. Because murre density is significantly reduced within a radius of 9 km around the OWFs, 53% of the German Exclusive Economic Zone in the North Sea would be affected by the OWFs. In total 54,000 (i.e. 60%) murres occurring in the German North Sea in autumn are using the affected area. Overall, 30% of the murre population in the German North Sea in autumn would experience displacement and thus in consequence habitat loss. This illustrates the possible threat for murres in the southern North Sea, if OWFs will be implemented in huge dimensions.

REMOTE TRAP MONITORING: SO MANY TRAPS, SO LITTLE TIME

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Invasive predators pose significant risks to entire ecosystems - especially delicate communities of native species on islands. On the Hawaiian island of Lānaʻi, predators such as feral cats and rats threaten rare and endangered species including ʻuaʻu (Hawaiian petrels; *Pterodroma sandwichensis*), kāhuli (tree snails; *Partulina variabilis* and *P. semicarinata*), and hāhā (*Cyanea lobata*). Therefore, reducing predators across the landscape benefits multiple species. The response to predator control can be dramatic; for instance, in areas with cat and rat control on Lānaʻi, ʻuaʻu reproductive success has increased three-fold over just 3 years. Though effective, trapping across Hawaiʻi's montane landscape requires considerable resources. While Good Nature A24 self-resetting traps provide efficient rat control with two to three staff visits/year (compared to single-kill snap traps), landscape-level cat control using live traps challenges staff capacity. Live trapping traditionally requires frequent monitoring by staff to ensure quick, humane response times to captures of both target predators and bycatch species. New remote sensing tools provide an alternative to in-person field checks. We deployed multi-link mesh network Cuddeback Cuddelink™ camera systems that provide several benefits over telemetry and cellular trail-cameras. A Cuddelink 'home' camera connects up to 15 additional cameras on a single cell plan, allows use across areas with variable cellular coverage, and provides daily visual confirmation of each trap's

status. Our cost/benefit analysis comparing the Cuddelink system to daily, in-person monitoring show a savings in reduced staff hours that far exceeds the cost of setup, use, and maintenance of the camera system.

NOT SO MICE? THE CONSUMPTIVE AND COMPETITIVE IMPACTS OF INVASIVE HOUSE MICE (*MUS MUSCULUS*) ON SOUTHEAST FARALLON ISLAND

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The eradication of introduced house mice (*Mus musculus*) has been proposed to protect and restore the native ecosystem of Southeast Farallon Island (SEFI), California. SEFI is home to 15 breeding seabird species and endemic fauna such the Farallon arboreal salamander (*Aneides lugubris farallonensis*). While the negative impact of introduced species on islands has been well documented and includes direct and indirect impacts on vegetation, native wildlife, and ecosystem function, little is known about the diet of invasive house mice on Southeast Farallon Island. We used stable carbon and nitrogen isotope analysis combined with isotopic niche and dietary mixing model approaches to quantitatively assess the diets and foraging niches of house mice on Southeast Farallon Island to better understand their interactions with native flora and fauna. We found that plants are the most important resource for house mice in the spring when plants are most abundant and house mouse populations are low. However, plants decline in importance throughout the summer and fall as mouse populations increase, and seabird and insect resources become relatively more available and important to house mice. In addition, when the mouse population is high on Southeast Farallon Island and plant resources are less abundant the isotopic niches of house mice and salamanders overlap significantly indicating the potential for competition, most likely for insect prey. These results indicate how seasonal shifts in both mouse abundance and resource availability are key factors that drive the consumptive and competitive impacts of introduced house mice on this coastal island ecosystem.

COMMON MURRE BREEDING ATTEMPTS STYMIED BY BALD EAGLE DISTURBANCES DESPITE FAVORABLE FORAGING CONDITIONS IN 2020

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Common murre (*Uria aalge*) reproductive success at the Yaquina Head seabird breeding colony has been variable over the last decade, with a sustained period of failed nesting attempts (2014-2017), followed by relatively high productivity (2018, 2019). In 2020, productivity was near zero (0.029 ± 0.09 chicks fledged) despite relatively favorable foraging conditions**.** Murre reproductive success is driven by varying contributions from both bottom up and top down influences, and predator disturbance generally appears to be more strongly associated with productivity in years with poor foraging

conditions (e.g. Pacific Marine Heat Wave 2014-2017). In 2020, foraging conditions suggested an auspicious year for breeding murres, however higher than average bald eagle (*Haliaeetus leucocephalus*) disturbances (0.58/hr) and egg depredation (671 eggs) led to near breeding failure, with only three chicks successfully fledged from our 131 monitored nests. In 2020, we documented a group of 15 eagles simultaneously hunting at the Yaquina Head colony; the largest aggregation over our study period (2007-2020). Eagle surveys in the Yaquina Estuary (and coast wide) have shown a gradual steady increase in population since 2012, however it is unclear in 2020 whether there was an increase in local eagle populations or a change in eagle foraging conditions and behaviors. For instance, park closures as a result of COVID-19 restrictions may have indirectly effected eagle presence and density at Yaquina Head. Conditions in 2020 could indicate a shift to more predator driven common murre reproductive success regardless of prey availability, and assuming the trend in eagle population continues, could become the new normal.

HOW TO MEASURE IMPACT? NEW METHODS FOR DESCRIBING THE VISIBLE AND HIDDEN IMPACTS OF PLASTIC POLLUTION

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Plastic has been adrift at sea for over 60 years. The interactions between these particles and animals is largely negative, often causing entanglement and ingestion injuries. When ingested, plastics and their associated chemicals may contribute to sub-lethal impacts on an individual. Sub-lethal impacts do not always lead to mortality, but effect animal function and physiology. We conducted a systematic review of the sub-lethal impacts of plastic ingestion on wildlife. Of the papers returned by the search, seabirds were the most studied higher-vertebrate animal group (53%). However, the metrics used to determine the physiological impact of plastics on animals were often based on unvalidated body condition indices, such as condition score or body mass indices (BMI). We recognise the key to understanding pollution impacts requires a comprehensive understanding of seabird physiology. Using a range of metrics, we explored how plastics disrupt the gut health and physiology of the Short-tailed (*Ardenna tenuirostris*) and Flesh-footed Shearwater (*A. carneipes*), two species which are directly threatened by the ingestion of plastics. We used fatty acids (FA) analysis, which proved to be a promising tool to detect impacts in some shearwater species. FA in the breast muscle in Short-tailed Shearwaters showed a relationship with mass of plastic ingested ($F_{4,9} = 5.15$, 0.019, $\lambda = 0.696$). We then described the histopathology and microbiome of shearwaters with both high and low levels of ingested plastics, to determine if plastics change gut function. Understanding that there is no one reliable metric to measure impact on wildlife, we argue for the use of multiple tools when exploring this complex toxicology issue.

BIOLOGICAL TRAITS OF SEABIRDS PREDICT EXTINCTION RISK AND VULNERABILITY TO ANTHROPOGENIC THREATS

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Seabirds are heavily threatened by anthropogenic activities and their status is deteriorating rapidly. Yet, these pressures are unlikely to uniformly impact all species. It remains an open question if seabird species with similar ecological roles are responding similarly to human pressures. Here we compile and impute eight traits across all 341 species of seabird to test whether threatened and non-threatened seabirds differ in trait space and identify traits that render species vulnerable to anthropogenic threats. We reveal distinct segregation in trait space based on threat status indicating anthropogenic impacts are selectively removing large, long lived, pelagic surface feeders with small habitat breadths. We further find that species with small habitat breadths and fast reproductive speeds are more likely to be threatened by habitat-modifying processes; whereas pelagic specialists with slow reproductive speeds are vulnerable to threats that directly impact survival and fecundity. Our results suggest targeted conservation strategies must be implemented to ensure a functionally similar suite of seabirds will not be lost in the near future.

CHANGES IN LATE WINTER DISTRIBUTION OF SPECTACLED EIDERS IN ASSOCIATION WITH SEA ICE RETREAT IN THE BERING SEA

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Everything we know about the wintering ecology of Spectacled Eiders (*Somateria fischeri*), a species of sea duck endemic to the Bering Sea and listed under the Endangered Species Act, we have learned during years of relatively high sea ice cover. Historically, wintering Spectacled Eiders have resided in polynyas and leads within the pack ice south of St. Lawrence Island. Studies to date suggest that moderate sea ice conditions in this core wintering area are ideal for eiders. During the winters of 2017–2018 and 2018–2019, sea ice extent in the Bering Sea reached unprecedented lows and the core wintering area used by Spectacled Eiders was ice-free for much of these winters. However, we have little information on the behavior or distribution of Spectacled Eiders during years of low sea ice cover. In May 2018, we deployed 39 satellite transmitters in Spectacled Eiders from the Yukon Kuskokwim Delta breeding area. In winter 2018–2019, we observed three apparent patterns in late winter distribution. Some marked individuals remained in the ice-free core wintering area south of St. Lawrence Island (once settled in the area, the maximum distance moved was 75 km until spring migration; n = 5), some moved closer to the south coast of St. Lawrence Island (max distance moved = 87 km, n = 12); and some moved north of St. Lawrence Island as far northwest as the coast of Chukotka (n = 7;max. distance moved was 1085 km). Northward movements coincided with northward retreat of sea ice, which occurred much earlier than average. These results question the current relevance of previously-collected Spectacled Eider winter distribution data in rapidly changing conditions in the Bering Sea.

CONDUCTING REMOTE SEABIRD FIELDWORK IN ALASKA DURING THE TIME OF COVID-19

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The Alaska Maritime National Wildlife Refuge has been monitoring seabirds at remote locations across coastal Alaska for over 40 years. Data from these sites provides a wealth of information that we use to track the health of seabird populations and the marine environment that these species depend on. The challenges that we normally face conducting seabird fieldwork in coastal Alaska are exacerbated by the COVID-19 pandemic, particularly where access to field sites requires transport via ship or commercial air travel through remote communities. Medical evacuation from our field sites is difficult under normal circumstances, but significantly more challenging given safe travel restrictions due to COVID-19. During 2020, we consulted with our Refuge partners and made the difficult yet necessary decision to cancel nearly all remote fieldwork. Instead, we turned our attention and resources to a backlog of existing data projects. We also spent time researching ways to modify our monitoring program to mitigate some of the challenges that COVID-19 imposes on remote fieldwork. Drawing upon what we learned in 2020, we are currently planning the 2021 field season, including the development of a COVID-safe Operations Plan that draws on a number of different sources, including recommendations from the CDC and the University-National Oceanographic Laboratory System (UNOLS). We are proactively planning the return to our remote field locations to ensure success in both the best and worst case scenarios, recognizing that the current public health landscape is dynamic, and will likely remain so for the foreseeable future.

MARINE DEBRIS INGESTION BY PACIFIC SEABIRDS AND POTENTIAL POPULATION IMPACTS: QUANTIFYING THAT WHICH YOU CANNOT COUNT

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There are numerous anthropogenic pressures shaping the survival of seabirds in the Pacific Ocean. Potential population-level responses are readily quantified for threats that cause acute mortality/morbidity and are visible and countable, such as direct fisheries mortality, oil spills and to some extent, predation on breeding islands. By contrast, mortality associated with marine debris and other pollutants, resource competition and climate, occurs at sea and cannot be readily counted. We pose the question- how can you quantify that which you cannot count? We explore several recent examples of peer-reviewed publications on marine debris ingestion by tube-nosed seabirds and discuss them in a Pacific Ocean context. Here we propose that direct mortality from the ingestion of marine debris is an underestimated threat to seabirds in the Pacific Ocean. We posit that the population consequences of marine debris ingestion, for some species, may be as severe as other known serious threats such as direct mortality due to fisheries by-catch. Given the unknowns in relationships between ingested plastic and contaminants, nutrition and potential additive pressure with other threats, direct mortality may just be the tip of the plastic pollution iceberg.

NON-BREEDING SPATIAL OVERLAP AND ACTIVITY BUDGETS OF THREE NORTH ATLANTIC ALCID SPECIES

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There is increasing recognition of the energetic challenges faced by high-latitude seabirds outside the breeding season, due to lower productivity, cold temperatures, reduced daylength, and stormy weather. Pursuit-diving species, such as alcids, may be especially challenged due to the high energetic costs of flight to locate areas of higher productivity. Although more interspecific interactions are predicted during breeding, when multiple species are spatially constrained to areas near colonies, lower prey availability during non-breeding suggests that spatial overlap and interactions among species may remain high. Little is known, however, about the spatial distribution and overlap of alcid species during non-breeding. We investigated the spatial overlap of non-breeding Razorbills (*Alca torda),* Common Murres (*Uria aalge*) and Atlantic Puffins (*Fratercula arctica)* in the Northwest Atlantic along with time-activity budgets (i.e., proportion of time spent diving, resting, flying). Geolocation-immersion loggers were deployed (10-25 loggers/species) on chick-rearing alcids at two colonies on the northeast Newfoundland coast during 2019, which were retrieved during summer 2020 (n = 5, 3, 3, respectively). Initial results on the spatial distribution and overlap of core use areas (50% kernel density) among species during autumn, winter, and spring will be presented along with season-specific comparisons of time-activity budgets. Findings will provide insight into species interactions during periods of lower productivity, species-specific abilities to cope with environmental change, and priority areas for pelagic biodiversity conservation and protection.

OCCURRENCE OF PINK-FOOTED SHEARWATERS AS BYCATCH IN PACIFIC FISHERIES

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Pink-footed Shearwater (*Puffinus creatopus*) have a very restricted breeding range, three Chilean islands, and travel north in the eastern Pacific Ocean during the non-breeding period. The Pink-footed Shearwater is the largest of the shearwaters and one of three regularly occurring white-bellied shearwaters in the Eastern North Pacific Ocean. Males, females, and juveniles have similar appearances. They tend to be silent at sea and grow up to 45cm (1.5 ft) in length, with a 106 cm (3.5 ft) wingspan. Pink-footed Shearwaters are attracted to fishing vessels as tempting sources of food, often getting entangled in gear. However, not a lot of information has been collected about the rates of bycatch for this species. In general, seabirds are among the most threatened groups of birds; Pink-footed Shearwaters are listed as vulnerable on the IUCN Red List. In collaboration with the NOAA's Southwest Fisheries Science Center and the Pacific States Marine Fisheries Commission, a guide was created to help fisheries observers identify, document and give aid to injured seabirds. Seabirds are integral components of a healthy and resilient ocean. Regardless of the species of birds encountered during fishing activities, photographs of birds (dead or alive) help scientists understand interactions between fisheries and seabirds.

INDIVIDUAL VARIATION IN SPATIAL FORAGING BEHAVIOR IN BLACK-LEGGED KITTIWAKES

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Seabirds are commonly referred to as sentinels of the marine environment. Changes in seabird behavior and reproductive success can be indicators of greater changes in the environment. As events like marine heatwaves increase in frequency, investigating individual plasticity can be critical for our understanding of how much individuals are able to alter behavior in the face of environmental changes. Black-legged kittiwakes (*Rissa tridactyla*) on Middleton Island, Alaska exhibit seasonal and annual variation in foraging behavior. However, the extent of individual variation within and among years is still relatively unexplored. In this study, we explore how individual variation in foraging trip characteristics impact breeding success in black-legged kittiwakes. Breeding kittiwakes have been monitored on Middleton for decades. Here, we combined breeding data along with seven years of foraging data from GPS deployments conducted between 2013-2020. As anticipated, we found that foraging trip characteristics were highly variable both between and among years and between and among individuals. In particular, birds foraged farther from the colony during and after a marine heatwave 2014-2016 when colony-wide productivity was very low. We conclude the marine heatwaves could have bottom-up impacts on seabirds via impacts on their foraging behaviour that ultimately affects fitness.

NEW STRATEGIES FOR VISUALIZING SEABIRD DISTRIBUTIONS USING THE COLORIST PACKAGE IN R

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Seabird biologists have long been at the forefront of efforts to record animal locations and activities with biologging devices. As data from biologgers become more abundant, detailed, and available, new opportunities and challenges arise for visualizing where and when seabirds occur. We developed the *colorist* package for the R Statistical Computing Environment in an effort to expand the set of tools available to researchers for visualizing distribution data. *Colorist* contains functions for displaying sequential change in distributions through the use of small multiples. It also contains functions for extracting several features of interest from a sequence of distributions and for visualizing those features with perceptually balanced hue-chroma-luminance (HCL)-derived color palettes. Resulting maps allow for “fair” visual comparison of occurrence, abundance or probability density values across space and time and can be used to address questions about where, when, and how consistently a species or individual is likely to be found. Functions can also be harnessed to visualize distributions of multiple seabird species or individuals within a single time period when research questions are focused on understanding the degree to which they partition space. We anticipate *colorist* will be useful to seabird biologists pursuing a wide range of research questions that depend on understanding spatiotemporal patterns and representing those patterns in static maps.

COMPARATIVE EGG ATTENDANCE PATTERNS OF INCUBATING POLAR PETRELS

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The internal environment of eggs in most birds is regulated by transferring heat energy through contact incubation, maintaining nest microclimate, and frequent egg turning by the incubating parent on its nest. However, we lack information about egg attendance patterns in birds that breed in polar environments where variations in life history are expected to influence incubation behavior. Moreover, crevice/burrow nesting petrels in high latitude regions are known for periodically leaving their egg unattended but there is little reporting on the condition of unattended eggs. At Dumont d'Urville Station, Antarctica, we studied the incubation behavior of 28 snow (*Pagodroma nivea*) and 21 cape (*Daption capense*) petrel pairs using egg loggers that recorded egg turning rates, orientation changes, and temperatures at 1 Hz for durations of 3-6 days. Egg turning frequency (1.31 ± 0.33 vs. 1.38 ± 0.39 turns h^{-1}), angle change per turn (43.1 ± 43.2 vs. $48.6 \pm 43.7°$ $turn^{-1}$), and egg temperature (34.1 ± 2.3 vs. 34.1 ± 2.0°C) were nearly identical for snow and cape petrels, respectively. However, during egg neglect, snow petrel eggs cooled to 5.5 ± 1.8°C over 91 minutes but were rewarmed by parents in only 76 minutes at a rate of 0.33°C min^{-1}. Excluding egg neglect periods, turning rates and egg temperatures for both petrel species were low (0.8 turns h^{-1} & 3.5°C) relative to other seabirds measured using the same loggers. Egg temperatures were within 1-2°C of other high latitude petrels during regular incubation and remained several degrees above freezing when neglected, which was likely attributed to nesting in crevices that buffers environmental conditions.

ELEMENTAL CONCENTRATIONS IN THE FEATHERS OF BONIN PETRELS (PTERODROMA HYPOLEUCA) FROM MIDWAY ATOLL

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Seabirds are ideal biological indicators of environmental contamination because they are long-lived upper-trophic predators, whose feathers can be sampled non-destructively. This study compares six elemental concentrations in Bonin petrel feathers sampled at Midway Atoll in 2014-15 with historical samples from the 1990s (Burger and Gochfeld 2000) and provides an updated baseline for future contamination monitoring. To this end, we sampled 42 hatch-year (HY) and 42 after hatch-year (AHY) carcasses from Sand Island, and analyzed breast and first primary feathers for As, Cd, Cr, Pb, and Se via inductively coupled plasma-mass spectrometer and for Hg via cold vapor atomic-absorption spectroscopy. Of these six elements, Hg had the greatest concentration in AHY birds (9,880 ± 4,710 ng/g) and the second greatest concentration in HY birds (2,130 ± 953 ng/g). These values were lower than the

historical concentrations (AHY: 19,700 ± 1,080 ng/g, HY: 3,870 ± 220 ng/g). While As, Cd, Cr, and Se concentrations also decreased, the mean contemporary concentration of Pb in HY birds (1,120 ± 2,090 ng/g) was greater than the historical concentration (802 ± 164 ng/g). These results suggest that Bonin petrels are exposed to mercury via their mesopelagic fish and squid prey, which generally have greater concentrations due to methylation processes in deeper water. HY birds may also be exposed to lead through their nesting sites on Sand Island. This study, which highlights the use of seabirds as indicators of changing pollutants over time, suggests that mercury concentrations may be decreasing in the central north Pacific Ocean.

ACROSS THE NORTH PACIFIC, DIETARY-INDUCED STRESS OF BREEDING RHINOCEROS AUKLETS INCREASES WITH HIGH SUMMER PDO INDEX.

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Range-wide studies of breeding seabirds may provide insights into the mechanistic links between large-scale climate variability and local changes in marine ecosystems. However, such studies represent a challenging task, due to large differences in local oceanographic processes, prey diversity, and geographical differences in seabird diet composition. In the North Pacific, the Pacific Decadal Oscillation (PDO) is a dominant climate index, characterized by contrasting trends in sea surface temperatures between the western and eastern North Pacific. High values of the PDO indicate generally warm conditions in the central and eastern North Pacific but cold conditions in the west. To understand how inter-annual variability in the PDO affects rhinoceros auklets (*Cerorhinca monocerata*) across the North Pacific, we measured inter-annual changes in nutritional stress (as reflected in plasma levels of corticosterone) of adults breeding on five colonies (two and three colonies from the western and eastern Pacific, respectively). We also examined concurrent changes in mass and energy content of food loads delivered to chicks. We found that a higher summer PDO index was associated with increased nutritional stress and lower food load mass and energy content in both the western and eastern North Pacific colonies. These results indicate that the energy content of food loads and nutritional stress incurred by breeding adults represent a common metric, which a) alleviates the colony-specific effects on diet composition, and b) reveals that a high summer PDO index may induce negative bottom-up effects on breeding populations of rhinoceros auklets across their reproductive range.

ACOUSTIC MONITORING OF ENDANGERED HAWAIIAN PETRELS AND DISCOVERY OF A POPULATION OF BAND-RUMPED STORM-PETRELS ON THE ISLAND OF LĀNAʻI

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The island of Lānaʻi is home to a nesting colony of ʻUaʻu (Hawaiian Petrel, *Pterodroma sandwichensis*) that has been presumed extirpated multiple times over the last century, but managed to persist in the face of habitat loss and invasive predators. When conservation efforts on the island ramped up in 2016, the full picture of the distribution, density, and trends of ʻUaʻu was unclear. Automated acoustic recorders allowed us to use Conservation Metrics' deep neural network analysis for identifying and applying a standardized method to quantify seabird call rates. We used the call rates to assess distribution and status of the island's ʻUaʻu, as well as look for Hawaiʻi's two other nocturnal, montane-nesting, endangered seabirds: ʻAʻo (Newellʻs Shearwater, *Puffinus newelli*), and ʻAkeʻake (Band-rumped Storm-petrel, *Oceanodroma castro*). In partnership with the Kauaʻi Endangered Seabird Recovery Project, we systematically surveyed the majority of the remaining native forest to map ʻUaʻu relative density. We then analyzed call rates at static locations in the ʻUaʻu colony each year from 2016 to 2019 to compare activity over time, and found a nearly 33% year-over-year increase, correlating with increasing predator control effort across the colony. In addition to ʻUaʻu, we detected several visits by ʻAʻo, which are thought to have historically nested here. We also discovered high call rates and consistent activity of ʻAkeʻake along Hauola Canyon, strongly suggesting a breeding colony, the first time this has been recorded on Lānaʻi. Acoustic monitoring on Lānaʻi for endangered nocturnal seabirds has provided valuable insights to direct and evaluate management efforts, and guide future actions to protect these imperiled species.

REPRODUCTIVE INDICES OF COMMON MURRES AND MARBLED MURRELETS IN OREGON INDICATE MURRELETS ARE MORE RESILIENT DURING POOR YEARS

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Fledgling to adult age ratios and fledgling encounter rates at sea were used as measures of annual reproductive performance for Common Murres (*Uria aalge*, 'murre') and Marbled Murrelets (*Brachyramphus marmoratus*, 'murrelet') over 28 years in 2 biogeographic regions of the Oregon coast. Where the adult murre population and the encounter rate of murre fledglings was much higher than for murrelets overall, the drop in productivity during El Nino and marine heat wave years was significantly greater for murres. This was true in both bioregions; north and south of Cape Blanco. Adult murre body size is roughly 5 times that of murrelets, which may be a factor in their success in years of low prey availability, but also the two species appear to exhibit different foraging strategies at sea.

GENETIC DIVERSITY AND POPULATION STRUCTURE OF ALEUTIAN TERNS IN ALASKA: A PRELIMINARY ASSESSMENT

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The Aleutian tern (*Onychoprion aleuticus*) is a seabird with a small global population and breeding sites restricted to Alaska and the Russian Far East. Aleutian Tern populations at known breeding sites within Alaska appear to be in decline since the 1960's. However,
population trends are difficult to assess due to low breeding site fidelity, breeding habitat plasticity, gaps in colony counts, variability in colony attendance within and among years, and
potential for high inter-colony movement. An important part of developing a statewide monitoring framework and evidenced-based management and conservation strategy is to initiate the study of population genetic structure within Alaska. Blood, feather, and egg samples have been collected opportunistically and as part of other field studies (e.g. stable isotope analysis) since 2011 and are the foundation for assessment of genetic diversity and population structure within Alaska. We developed a panel of 16 polymorphic microsatellite loci from those previously published for related species and genotyped 34 individuals from three breeding sites. All breeding locations and eight of 16 loci harbor private alleles. Aleutian Tern genetic diversity appears comparable to the congeneric Sooty Tern based on preliminary measures of number of alleles and expected heterozygosity. The optimization of this microsatellite panel facilitates the expansion of sampling depth per colony and across Alaska as statewide surveys occur. Ultimately, genetic monitoring across decades can be routinized using this panel, and we hope to expand sampling into Russia in order to estimate distribution-wide genetic exchange.

DOES PRE-LAYING DIET INFLUENCE NESTING PROPENSITY AND SUCCESS IN ALEUTIAN TERNS?

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The Aleutian tern (*Onychoprion aleuticus*) is a species of concern in Alaska due to a steep decline in the breeding population over the past few decades. Due to the small population size and ephemeral behavior of this species on the nesting grounds, there is little basic biological information available and data gaps have hindered the identification of potential drivers of the population decline. Significant unknowns include the diet of Aleutian terns during the breeding season, and an understanding how warming ocean conditions around Alaska over the past few decades could be influencing prey availability. To begin to address these questions, we used bulk stable isotope analysis of eggshell

membranes to investigate the pre-laying diet of female Aleutian terns. Nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) stable isotope ratio values were obtained for 82 eggshells collected during 2017-2020 from multiple colonies across the Kodiak Archipelago. Preliminary analysis indicates that $\delta^{13}C$ values were significantly higher in 2017 (ANOVA, p-value = 0.0004) than the other three years. Aleutian terns apparently fed on more offshore prey types in 2017, potentially indicating poor food availability inshore closer to breeding colonies. During our four-year study, 2017 also had the lowest number of documented nesting attempts and poor hatching success. Regime shifts in the Gulf of Alaska could also be affecting the prey availability over much larger temporal and spatial scales than examined in this study, and be a factor in the long-term decline of Aleutian tern breeding populations across Alaska.

PATHS TO UNDERSTANDING SEABIRD RESPONSE TO HABITAT, ECOSYSTEM, AND CLIMATE CONDITIONS USING SPATIO-TEMPORAL MODELS

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Seabird and commercial fish distribution may overlap in space and time due to common drivers related to marine productivity and habitat suitability. Research during the past decade has developed new spatio-temporal modelling techniques to inform habitat, climate, ecosystem, fisheries stock assessments and management. The inclusion of seabird at-sea survey data, as well as other data types such as nesting location, wreck timing and magnitude, or seabird-fisheries interactions may inform ecosystem-based fisheries management efforts. Similarly, these modelling approaches may be generally applied to understand seabird dynamics and ecology. In this talk, I will briefly review how spatio-temporal models analyzing multiple response variables are being used in fisheries science, emphasizing: (1) the ability to predict densities and total abundance over a fixed spatial area while accounting for correlations across space and time (2) the potential to combine information from multiple sampling programs, each having different sampling protocols and operating over different areas and/or seasons; and (3) insights gained from jointly analyzing diet information, physiological condition, and numerical abundance as well as their response to regional environmental conditions. I will then speculate about potential applications for seabirds, including: (1) estimating overlap between seabird foraging distribution and fishing operations; (2) relating breeding success and diet to spatially varying prey densities; and (3) forecasting future shifts in seabird distribution during climate change. I hope to spark discussion regarding future research that can incorporate seabirds within habitat, climate, ecosystem, and stock assessments.

POST-COLLISION IMPACTS AND SEARCH BIASES IN A STUDY OF ENDANGERED SEABIRD POWER LINE COLLISIONS

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Power line collisions have been identified on Kaua'i as a potential contributing factor to the large-scale decline of both Hawaiian Petrel (*Pterodroma sandwichensis*) and Newell's Shearwater (*Puffinus newelli*), but the scale of the problem is unknown. From 2012 to 2019 we conducted observations for seabird power line collisions in all regions of Kaua'i, documented grounded seabirds and assessed crippling and environmental biases – both poorly studied facets of power line collision research. We directly

observed 104 powerline collisions and detected 85 grounded seabirds. While some collisions resulted in birds falling lifelessly out of the sky, most resulted in seabirds flying or gliding outside of the search area. This means that traditional ground searches would underestimation of total collisions by 78-88% if not accounting for crippling bias. We tested environmental bias by comparing our ability to conduct ground searches for carcasses, "searchability", across multiple variables. Environmental bias resulted in significant reductions in searchability across regions, environment types, and power line heights. Furthermore, 43% of observed collisions occurred at unsearchable power lines (mainly spanning steep valleys), which included the majority of the island's tallest power lines, further highlighting the unreliability of ground searches for estimating the number and geographic distribution of collisions. We detected power line collisions in every region of Kaua'i, in every environment type, and at all power line heights monitored. The data collected for this study are critical for assessing the scale of seabird power line collisions and quantifying the biases inherent in traditional ground searches.

REDUCED FLEXIBILITY DURING INCUBATION DRIVES REPRODUCTIVE FAILURE FOR INEXPERIENCED CASSIN'S AUKLET PAIRS

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Many seabird species maintain long-term breeding partnerships. This behavior is often explained by the fact that new (inexperienced) pairs have lower breeding success than familiar (experienced) pairs. The relationship between pair experience and reproductive success, however, is often confounded by other potentially important predictors of breeding performance, such as individual experience, which makes it difficult to show a clear effect of pair experience. Additionally, few studies have shown behavioral differences between new and experienced pairs making the benefits pair experience unclear. Using a long-term dataset of known-age Cassin's auklets (*Ptychoramphus aleuticus*) breeding on Southeast Farallon Island, we show that hatching success improves with pair experience, independent of the experience of each partner, but that this relationship depends on oceanographic conditions. In years with reduced upwelling and thus reduced prey availability for Cassin's auklets, hatching success was higher among more experienced pairs, yet pair experience did not affect hatching success in other years. To evaluate the behavioral basis of this pattern, we monitored incubation coordination in new and experienced breeding pairs during three years (2017-2019. In environmentally favorable years (2017 and 2018), incubation coordination was high for all pairs with few instances of egg neglect. In an unfavorable year (2019), while egg neglect was higher for all pairs, inexperienced pairs were much more likely to abandon the egg. Our findings suggest that inexperienced pairs may be less tolerant of egg neglect by one of the partners and thus less flexible, leading to breeding failure during environmentally challenging periods.

A SPATIAL ANALYSIS OF WEDGE-TAILED SHEARWATER FALLOUT ON SOUTHEAST O'AHU, HAWAI'I

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Attraction to artificial light at night causes hundreds of fledgling Wedge-tailed Shearwaters (*Ardenna pacifica*) to strand on land every year. Fallout hotspots have been identified near brightly lit structures, like sports fields and resorts. In this study, we explored the spatial distribution of grounded shearwaters to quantify the drivers of fallout hotspots. We used an 8-year time series of road surveys, spanning a change in highway lighting, to document the timing and GPS location of road-killed shearwaters along a coastal highway on southeast O'ahu, during which a change in highway lighting occurred. We compared fallout distribution during 4 years (2012-2015) with high pressure sodium (HPS) streetlights and during 4 years (2016-2019) with light-emitting diode (LED) streetlights, and did not find a spatial difference between these two lighting regimes. We also compared the spatial distribution of fallout across three wind regimes, north-northeast trade winds (NNE), east-northeast trade winds (ENE), and light variable winds (LV), finding no difference across regimes. Using a fishnet grid to divide our survey route into sections co-registered with remotely-sensed light imagery from NASA, we modelled the effect of physical structures and geographical features on the number of carcasses found within each cell. Distance to the colony, night-time radiance, and road length were significant predictors, with more Wedge-tailed Shearwater carcasses found in grid cells with longer road sections, higher radiance values, and shorter distance to the colony. Our findings suggest that management should target brighter areas in close proximity (<6 km) to the colony.

EXPERIMENTAL EVIDENCE THAT SOCIAL INFORMATION AFFECTS HABITAT SELECTION IN MARBLED MURRELETS

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Habitat selection decisions impact individual fitness and mediate population dynamics; understanding how threatened species select habitat is thus critical for discerning the biological processes structuring populations and developing conservation strategies. Marbled Murrelet (*Brachyramphus marmoratus*; hereafter murrelet) populations have declined due to loss of late-successional forest nesting habitat and changing ocean conditions that impact foraging success. Most other alcids nest colonially and nesting murrelets seem to aggregate in stands, yet the role of social information in nest site selection is unknown. In 2016 we experimentally simulated presence of murrelets at 14 randomly chosen potential breeding sites by broadcasting murrelet calls throughout the breeding period. Between broadcasting bouts, we recorded calls of wild murrelets and compared call rates with those recorded at 14 control sites (no broadcast). One year after playbacks ceased (2017) we conducted breeding season protocol surveys to test for signs of occupancy. Call broadcasts in 2016 increased daily odds of wild murrelets vocalizing during treatments by up to 15.4× (95% CI = 2.3, 125.4) relative to control sites. During the 2017 breeding season, the odds of occupancy were 10.0× (CI = 1.2, 81.4) greater at treatment sites than control sites. These results indicate social information influences murrelet breeding site selection; simulated conspecific presence appeared to attract prospectors in 2016 that continued occupying treatment sites the following year. This conspecific attraction implies murrelet nesting sites are likely to

remain occupied over time and that large tracts of nesting habitat may be important for supporting murrelet populations.

TRANSLOCATION OF BLACK-FOOTED ALBATROSSES FROM MIDWAY ATOLL, USA TO CREATE A BREEDING COLONY ON GUADALUPE ISLAND, MEXICO

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The Black-footed Albatross (*Phoebastria nigripes*) has a total breeding population of about 57,500 pairs, 95% of which nest on low atolls in the Northwestern Hawaiian Islands. Inundation of breeding colonies from sea level rise and storm surge associated with climate change is its most serious long-term threat. Protection of suitable nesting habitat and creation of new colonies on higher islands are among the highest priority conservation actions for this species. In collaboration with many partner agencies in the USA and Mexico, and under the Canada/USA/Mexico Trilateral Island Initiative, we are attempting to create a new breeding colony on Guadalupe Island, Mexico by translocating eggs and chicks from Midway Atoll. Guadalupe is a large, high island that is protected as a Biosphere Reserve and already supports a thriving colony of Laysan Albatrosses. In 2021, we plan to translocate 21 eggs and 15 chicks, and to increase the numbers in 2022 if all goes well. Eggs will be fostered into Laysan Albatross nests in which the natural egg is infertile. Chicks will be raised by hand until fledging using methods established for albatross translocations in Hawaii. Black-footed Albatrosses already forage in the cold waters of the California Current around Guadalupe, which are less likely to be affected by climate change than most other regions of the Pacific. Creation of a breeding colony in the eastern Pacific would increase the breeding range of the species and enhance its resiliency to climate change.

POPULATION GROWTH AND LONG-DISTANCE VAGRANCY LEADS TO COLONIZATION OF EUROPE BY ELEGANT TERNS *THALASSEUS ELEGANS*

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Elegant Terns (*Thalasseus elegans)* breed in the northern Gulf of California and the Pacific coast of southern California, with up to 95% (mean 78%, 1991-2014, Perez et al. 2020) of the population nesting on Island Rasa in the northern Gulf of California. Elegant Terns winter on the Pacific coast from Mexico to Chile, but some travel north during late summer and fall to the Pacific Northwest. Elegant Terns, because of their close association with the California Current off North America and the Humboldt or Peru Current off South America, have been repeatedly impacted by El Niño events that limit upwelling

and result in catastrophic (though temporary) declines of the fishes upon which they feed. During most El Niño events, large numbers of Elegant terns deserted their colonies and, beginning in 1982-1983, also moved much farther north along the west coast of North America during summer and fall than they had done previously. The removal of rodents from Isla Rasa in 1995 led to a near immediate increase in the population of Elegant Terns, and that increase was associated with a changing pattern in dispersal by the terns, including extraordinary movements to the Gulf of Mexico, the Atlantic coast of the United States, and to western Europe, where a few Elegant Terns successfully bred during 2010 to the present. In this paper we present the details of this changing pattern of dispersal, that we argue is a consequence of rapid population growth during ~ 1995 to present, and suggest this remarkable recovery and use of exploratory behavior could be representative of how seabirds in particular, and organisms in general may be able to escape "climate extinction".

INTERANNUAL VARIATION IN PERUVIAN BOOBY (*SULA VARIEGATA)* FORAGING, ASSESSED USING GPS TRACKING AND STABLE ISOTOPE ANALYSIS

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Peruvian boobies (*Sula variegata*) experience inter-annual shifts in oceanic productivity due to El Niño Southern Oscillation (ENSO). Such changes in conditions affect foraging costs and prey availability, and subsequently, foraging behavior and diet. Breeding boobies are susceptible to localized scarcity and shifts in their prey's spatial distribution, although they can adjust, to an extent, through change in diet and/or higher foraging effort through longer travel distances to prey patches and increased trip durations. We used a combination of stable isotope analysis and GPS tracking to explore variation in Peruvian booby diet and foraging behaviors over two years at Isla Guañape Norte, Peru. We found differences in blood nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) stable isotope values between years with differing ENSO conditions, suggesting that boobies may have shifted their diets and habitat use, respectively. Specifically, $\delta^{15}N$ values were higher in 2018 (14.8 ± 0.1‰) compared to 2016 (12.5 ± 0.2‰), which may indicate a diet of higher trophic level prey. The lower $\delta^{13}C$ values in 2018 (-15.3 ± 0.3‰) compared to 2016 (-14.9 ± 0.4‰) may indicate increased foraging in nearshore habitats. Ongoing GPS analyses will examine if stable isotope values are correlated with shifts in the foraging effort of Peruvian boobies, as measured by parameters including trip duration, trip distance, number of foraging trips, commute time and other metrics. This research will provide a greater understanding of the degree of flexibility in diets and foraging effort, relative to changing environmental conditions, and aid in the management and conservation of Peruvian boobies.

IS MITIGATION TRANSLOCATION AN EFFECTIVE METHOD FOR REDUCING LAYSAN ALBATROSS-MILITARY AIRCRAFT COLLISIONS?

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Wildlife-aircraft collisions (wildlife strikes) pose a serious risk to civil and military aircraft. Each year, Laysan Albatross (*Phoebastria immutabilis*) attempt to establish a breeding colony on the airfield at the US Navy's Pacific Missile Range Facility (PMRF) located on the island of Kaua'i, resulting in a hazard to safe aircraft operations at this facility. A long-term management program, with an emphasis on mitigation translocation (e.g., live-capture and translocation away from the area) of problematic individuals, has been conducted by USDA Wildlife Services. However, the efficacy of mitigation translocation as a non-lethal management tool is unknown, especially in island ecosystems. During 2018–2020, we conducted an experimental program to determine return rates of albatrosses translocated from PMRF. Radio-tagged Laysan Albatross were translocated to release locations either 2 km or 45 km from the PMRF airfield during two time periods (early and late) within the Laysan Albatross breeding season (November to April). We monitored for the return of radio-tagged birds to PMRF using automated tracking units placed around the PMRF airfield, hand tracking, and examining all Laysan Albatross that were live-captured on the airfield during the breeding season. Preliminary findings of our study suggest mitigation translocation has value as a management method to reduce the risk of albatross-aircraft collisions at PMRF.

ENVIRONMENTAL STRESSES EXPERIENCED BY SHORT-TAILED SHEARWATERS WINTERING IN SEPARATE AREAS

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Individuals of seabirds often use separate non-breeding areas and so they are expected to experience contrasting environmental stresses. Short-tailed Shearwaters (*Ardenna tenuirostris*) breed mostly in Tasmania in October –April but spend the non-breeding period (June – September) in two separate areas in the northern North Pacific. Half of them stay in the south-eastern Bering Sea, and the others stay in the south Okhotsk Sea. We investigated the migration and the foraging activity using geolocators, the trophic level and the mercury exposure using biomarkers in their flight feathers, and the relationships with the prey density using boat census and acoustics. Okhotsk birds made a greater number of shorter foraging bouts with lower proportional daily on-water time, fed on prey of lower trophic level but experienced higher mercury exposure in their wintering area, and showed larger interannual change of the incubating body mass than Bering birds. Birds tended to forage in the places where prey density was high in both wintering areas, but Okhotsk birds showed more apparent association than Bering birds. The short-tailed shearwaters breeding in a colony but wintering in the two separate areas experienced different nutritional and pollution stresses.

ANIMAL-BORNE VIDEO LOGGERS OFFER A NEW LOOK AT THE UNDERWATER FORAGING BEHAVIORS OF ADÉLIE PENGUINS IN ANTARCTICA'S ROSS SEA

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The Cape Crozier Adélie penguin *(Pygoscelis adeliae)* colony located in Antarctica's Ross Sea is one of the largest for this species. Foraging range is restricted during the breeding period as adults make frequent visits to the colony to provision chicks. As prey are depleted and the caloric needs of chicks increase through the summer, adults must modulate their foraging behavior and prey selection. A prey shift from crystal krill *(Euphausia crystallorophias)* to Antarctic silverfish *(Pleuragramma antarctica)* has been documented at the Cape Crozier colony during the late stages of chick rearing, but the range of other prey types and their proportion in the diet throughout the season is not well understood. In a pilot study during the 2018-2019 breeding season, Little Leonardo video loggers were deployed along with accelerometers on 27 chick-rearing adults. Preliminary analysis of 56 dives from 22 birds resulted in the identification of 937 prey capture events, 25% of which were identifiable to prey type, including krill, fish, pteropods, jellies, and squid. Initial analysis indicates a negative relationship between study day, beginning on December 11 and ending on January 1, and proportion of krill captured, consistent with seasonal prey switching. Our results indicate that video loggers can be used to identify a range of Adélie penguin prey and approximate prey consumption throughout the season. Through pairing video loggers and accelerometers, with time and depth recorders, we hope to identify the behavioral signature of capture events and pinpoint linkages between prey types and local environmental conditions, and further document a more diverse preyscape available to Adélie penguins.

RESULTS OF FIVE YEARS OF TRANSLOCATIONS OF HAWAIIAN PETRELS AND NEWELLS SHEARWATERS AT KILAUEA POINT NATIONAL WILDLIFE REFUGE

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Newell's Shearwater (*Puffinus auricularis newelli;* NESH) and Hawaiian Petrels (*Pterodroma sandwichensis;* HAPE) are both listed as Threatened and Endangered under the US Endangered Species Act and are declining due to collisions with power lines and structures often exacerbated by light

attraction, predation by introduced predators and habitat degradation. Translocation to protected breeding sites with social attraction was proposed in the 2015 Action Plan and 1983 recovery plan and was ranked as priority one in the 2011 interagency 5-year Action Plan. In 2012, funding became available to begin preparing for translocations to Kīlauea Point National Wildlife Refuge, home to one of the largest seabird colonies in the main Hawaiian Islands. A predator proof fence was completed in September 2014 and all non-native mammals were removed from the 7-acre fenced area by January 2015. In August 2015 habitat restoration began and 75 artificial burrows were installed. From 2015-2020 110 HAPE and 87 NESH that had not emerged from their montane burrows were removed by hand and transported via helicopter to the refuge. There they were hand-fed a fish, oil, Pedialyte® and squid mixture until they fledged. A total of 106 HAPE (96%) and 87 NESH (100%) fledged from the site. To date, five translocated HAPE (birds from the 2016 and 2017 cohorts) had returned to the site as adults and were recorded prospecting and copulating. Once complete, this project is expected to result in a new, secured and accessible breeding population of both species that – coupled with other protected and managed colonies - will be crucial to prevent the extinction of both species and restoring a missing component of the coastal ecosystem in Hawaii.

TIME-LAPSE CAMERAS AS RELIABLE AND ACCURATE TOOLS FOR BIOLOGICAL MONITORING OF PERUVIAN BOOBIES ON THE GUANO ISLANDS OF PERU

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Since historical times, Peruvian boobies (*Sula variegata*) have been recognized as an important guano-producer seabird in Peru due to their large numbers and dense colonies. They are also major bio-indicators and target conservation species within the Marine Protected Areas in Peru. Nevertheless, there is no long-term ecological monitoring programs other than estimates of their population size. We used time-lapsed cameras installed on several islands and walled-off headlands of Peru between 2016 and 2020 to evaluate their feasibility and accuracy to determine some aspects of the breeding and foraging behavior of Peruvian boobies. Time-lapse cameras were programmed at 15-min intervals, lasting approximately 6 months. The duration of feeding trips of chick-rearing adults were accurately determined when contrasting presence/absence of birds from the photographs with GPS tracks of the same birds (r^2=0.98). Nest survival curves were determined and causes of nest failures were identified (e.g. tick infestation). Breeding phenology was also determined on different islands arriving to the conclusion that boobies are highly asynchronous both within and across colonies. Inter-annual variations on these parameters linked to oceanographic conditions and fishing activities would shed light for a better understanding of seabird number fluctuations and conservation.

COLONIZATION OF NORTH AMERICA BY VAGRANT LESSER BLACK-BACKED GULLS (LARUS FUSCUS) IS LINKED TO POPULATION TRENDS IN GREENLAND

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Lesser Black-backed Gulls (*Larus fuscus*) have a dramatic and well-documented history of vagrancy to North America. Individuals were first reported in North America in the mid-twentieth century, and increased rapidly during the 1990s. While no conspecific breeding pairs have been found, individuals continue to appear in increasing numbers, with over 1000 individuals recorded each year since 2005. We argue that the rapid increase of Lesser Black-backed Gulls in North America resulted from repeated instances of vagrancy, driven by increasing population growth in Greenland, Iceland, and Northwest Europe. We studied the probable source population of vagrant Lesser Black-backed Gulls by relating annual incidence in North America to annual estimates of breeding populations, and population growth, in Greenland, Iceland, and the UK. Vagrant data were obtained from *Bird Observer* and Christmas Bird Count data, and breeding population data were extracted from national surveys of breeding birds. We found that breeding populations in Greenland best predict vagrancy to North America, while Iceland breeding populations are inversely correlated with vagrancy. We conclude that Greenland breeders are the primary source of North American Lesser Black-backed Gulls. Greenland's large population surge in the late 1980s, combined with known long-distance migratory tendencies of Lesser Black-backed Gulls, facilitated the strongly accelerated increase of vagrant Lesser Black-backed Gulls to North America.