

# 2018 Pacific Seabird Group 45<sup>th</sup> Annual Meeting



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ABSTRACTS

## DIVING BEHAVIOR OF PINK-FOOTED SHEARWATERS (*ARDENNA CREATOPUS*) REARING CHICKS ON ISLA MOCHA, CHILE

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During 19–28 March 2015, we tracked 6 chick-rearing adult Pink-footed Shearwaters (*Ardenna creatopus*) from Isla Mocha, Chile with global positioning sensors and time-depth recorders. We recorded 7 complete trips averaging  $4.2 \pm 2.5$  SD days. Chick-provisioning adults foraged within 334 km ( $175 \pm 100$  SD km) of Isla Mocha. Dives ( $n = 515$ ) occurred throughout the extent of the measured foraging range, but occurred most frequently within continental shelf waters to the north of Valdivia, Chile. Other regions with diving behavior were near Isla Mocha and north of Isla Mocha in the Gulf of Arauco and north of Concepción, Chile. Based on movement behavior analysis, adults spent the majority of their time at sea engaged in ‘resting’ ( $62\% \pm 6\%$  SD) and similar time ‘searching’ ( $16\% \pm 4\%$  SD) and ‘transiting’ ( $20\% \pm 5\%$  SD). The proportions of total number of dives associated with these three movement behavior classifications was similar (i.e.,  $60\% \pm 24\%$  SD during ‘resting’,  $22\% \pm 21\%$  SD during ‘searching’, and  $16\% \pm 10\%$  SD during ‘transiting’). Dives were relatively shallow (mean depth =  $1.6 \pm 1.2$  SD m, maximum depth = 10.1 m), and brief (mean =  $4.7 \pm 4.8$  SD s, maximum duration = 25.7 s). Dives occurred during day, night, and twilight, with the majority of activity during twilight ( $0.39 \pm 0.11$  SD dives hr<sup>-1</sup>) and day ( $0.16 \pm 0.05$  SD dives hr<sup>-1</sup>). Although our results are based on a small sample size, these data may be useful for informing modifications to fishing gear or fisheries policy to meet Chilean conservation goals for Pink-footed Shearwaters by reducing fisheries interactions and bycatch mortality.

## RADIO-TAGGING REVEALS UNPRECEDENTED BREEDING SEASON MOVEMENTS OF MARBLED MURRELETS

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The threatened Marbled Murrelet (*Brachyramphus marmoratus*) is an unusual member of the Alcidae family in that it flies inland to nest in mature forests. While studies of the species have been undertaken in other areas of its range, there is a paucity of data in Oregon related to breeding season behavior. This has led to uncertainty for forest managers charged with managing coastal forests for Marbled Murrelet habitat and timber production. In April of 2017, we initiated a radio telemetry study on the central Oregon coast to track the movements of Marbled Murrelets during the breeding season. We captured and tagged adult Marbled Murrelets (n = 61) at-sea during April and May and used aerial and ground-based radio-telemetry for tracking until September. Surprisingly, we did not find any inland movements that were indicative of breeding behavior, in spite of the availability of high quality nesting habitat in the study area. Instead of remaining in the study area as we expected, many of the tagged birds dispersed widely along the coast, up to 750 km from the initial capture location. Of our sample, 13% were relocated in Washington and 21% were relocated in California. Subsequent years of this study will help determine the extent of long-distance movements in years when individuals do initiate breeding.

ADVANCING EFFECTIVE ECOSYSTEM-BASED FISHERIES MANAGEMENT IN THE CALIFORNIA CURRENT SYSTEM: METRICS FOR QUANTIFYING PREY AVAILABILITY TO PREDATORS TO MODEL ALLOCATIONS OF ALLOWABLE BIOLOGICAL CATCHES

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Current harvest rules employed in fishery management plans of the California Current System (CCS) are based, in part, on preserving a portion of *stock biomass* for predators. While that strategy is commendable, considerations of prey availability within the ambits of various key predators might better inform ecosystem-based fishery management (EBFM). Therefore, we analyzed multiple physical and biological samples --- prey availability, predator population size, predator foraging area --- gathered 1985-2015 to quantify thresholds of *prey availability* at which predators switch diet or location, or incur negative demographic rates. In the process we identified “tipping points” at predator-defined spatial scales within the central CCS study area. Analyses included: 1) role of Common Murre predation on annual survival of California Central Valley juvenile salmon when alternate prey are not available; 2) role of forage species management and breeding colony protection in affecting population change, including location, in Brandt’s Cormorants; and 3) energetic constraints involved in prey switching among murre, cormorants and Rhinoceros Auklets.

## CONSERVATION PRIORITIES IN NORTHWESTERN MEXICO

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We carried out a literature review of the research and monitoring that has been carried out in Northwestern Mexico. We analysed management plans of the protected areas, public reports, scientific papers and databases such as e-bird. We identified the seabirds breeding on the islands in the study area and applied a categorisation scheme to those islands based on the conservation category (IUCN), the guild (coastal or pelagic) and a biodiversity index. There is a clear gap of information about the seabird status of most islands. The information of management plans is usually from more than 20 years and might be outdated. We identified as the top conservation priority the Revillagigedo Archipelago, followed by San Benito and Coronado Archipelagos. These groups of islands are on top of the conservation priorities mainly due to the presence of a Critically Endangered species (Townsend's Shearwater *Puffinus auricularis*, in Revillagigedo), Leach's Storm Petrel (*Oceanodroma leucorhoa*, San Benito and Coronado) and Ashy Storm-petrel (*Oceanodroma homochroa*, Coronado).

POPULATION ESTIMATE OF BLACK-VENTED SHEARWATER (*PUFFINUS OPISTHOMELAS*) ON NATIVIDAD ISLAND, MEXICO: 2016 & 2017 BREEDING SEASONS

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The Black-vented Shearwater (*Puffinus opisthomelas* Coues, 1864, BVSH) is a seabird with nocturnal habits and nests in burrows. Natividad Island is where 95% of the world population breeds and is a core area of the Vizcaino Biosphere Reserve. The remaining five percent of this species breeds on islands and islets of the west coast of the Baja California Peninsula and the Gulf of California. Because the restricted numbers of nesting sites, decline of the population in the past due to introduced cats and the unknown effect of the fisheries industry the IUCN has added the BVSH to the Red List under the “Near Threatened” category. On 2016 and 2017 we estimated the breeding population of BVSH by aerial photography from unmanned aerial vehicles and burrow occupancy. In the late 1990s B. Keitt estimated 114,000 burrows while on 2016 were recorded only 53,000, however it is considered that the methods used in 1998-1999 overestimated the population size. In addition, our results suggest that, on 2016, the island was visited by 31,790 breeding pairs. For 2017, the estimated breeding population increased by 39%, with a total of 44,235 nesting breeding pairs. The difference in population size observed between 2016 and 2017 may be directly related to a cascade effect caused by anomalous environmental conditions during the succession of “The Blob” and El Niño Godzilla events in 2013-16. Such events affected the food availability, causing important changes in the trophic and oceanographic condition of the California Current System, increasing competition for resources and space, reflected directly in the percentage of burrowing occupancy, and therefore, affecting the population size of the BVSH on Natividad Island.

IMPACT OF INTRODUCED PREDATORS ON THE REPRODUCTIVE POPULATION OF INCA TERN  
(*LAROSTERNA INCA*) IN PUNTA SAN JUAN, ICA, PERU

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Predation of Inca tern (*Larosterna inca*) eggs was detected from a study to determine reproductive success in the main nesting areas of Inca tern in Punta San Juan during the two reproductive seasons of 2014 and 2015. Forty artificial nests and forty natural nests were monitored, distributed homogeneously in four nesting areas. Reproductive success for both types of nest during 2014-1 was 0% because reproductive adults left the nesting zone, possibly due to a lack of local food availability. In 2014-2 75% of the natural nests (n = 30) and 40% of the artificial nests (n = 16) had eggs. However, in <3 weeks, 100% of the nests with eggs were predated by rats, showing an alarming problem before not noticed. The depredation of the natural nest were faster than the artificial nest, the media for natural nests was 2 days and for artificial nests was 6 days founding significant differences between both nests (p = 0.0008). In 2015-1 Tomahawk traps were placed in parallel to the monitoring (60 days / trap), obtaining a catch success of 43.3% (26 rats). In 2015-1 25% of natural nests (n = 10) and 17.5% (n = 7) of artificial nests with eggs; However, none of the natural egg nests were successful (n = 0) and 14% of the artificial nests had a chick (n = 1). All the rest was depredated. In 2015-2 Tomahawk traps (30 days / trap) were also placed, with a successful capture of 16.6% (5 rats). In 2015-2, 22.5% of the natural nests (n = 9) and 25% of the artificial nests (n = 10) had eggs, and after <30 days chicks were found in the 33.3% of natural nest with eggs (n=3) and in the 30% of artificial nests with eggs (n = 3). Although it was obtained a reproductive success from 0 to 27.78-29.41% between years, it is low compare to the reproductive effort. It is recommended to design a rodent control plan to increase the reproductive success of Inca terns in Punta San Juan.

## SEABIRD CONSERVATION IN NW MEXICO: LESSONS FROM A SENTINAL SPECIES, THE CALIFORNIA BROWN PELICAN

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The islands of the Midriff Area of the Gulf of California and surrounding marine habitats sustain significant numbers of breeding seabirds, including the migratory/resident California Brown Pelican (*Pelecanus occidentalis californicus*), which has in many parts of its range, been utilized as an overall indicator, sentinel, or “flagship” species in evaluations of general “ecological health” of their habitats, during the entire annual cycle, and applied to additional species. International aspects of seabird conservation (biological and political aspects) usually fall behind ecologically-defined needs. In practice, international conservation has been difficult to achieve regarding three essential aspects: (1) breeding islands in their demands for use by curiosity-seekers and exploitative uses, as well as the need to conserve entire island, interacting systems. Also, (2) essential non-breeding habitats and areas interfere with marine wildlife through competitive uses in these habitats, and fail to protect critical feeding habitats and roosting places (both day and night). Finally, (3) single-minded “multiple-uses” of essential seabird food resources often severely limit marine wildlife conservation. Due to the mainland-nearness of many nesting or roosting islands, these areas are also subject to high levels of possibly detrimental human activity reducing nesting populations of island-nesting waterbirds and other island-associated wildlife. Yet, nesting seabirds are sensitive sentinals or indicators of much additional, impending negative “human-competition” effect. Local conservation of nesting marine bird populations requires regular monitoring relative to a baseline, plus active management (including enforcement) to eliminate and minimize the effects of human disturbance, and consistent monitoring to document and interpret cyclic or changing environmental phenomenon. Viable biodiversity in the area enhances its natural values, which through controlled ecotourism, importantly also enhances the local economy. The CONANP (Comisión Nacional de Areas Naturales Protegidas) program at Bahía de los Ángeles, Guaymas, and Loreto, in addition to others in the region of Baja California and the Gulf of California, as resources allow, monitor Brown Pelican as well as other marine wildlife populations and their performances in the entire Midriff Region of the Gulf of California, and will use baseline data recently summarized to evaluate potential marine bird population effects, indicating potential effects on overall faunal diversity of the area.



## PLUMAGE GESTALT AS A PROXY FOR AGE-STRUCTURE IN A COASTAL SEABIRD: EVALUATING BREEDING PERFORMANCE OF BROWN PELICANS FROM COASTAL SURVEYS

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Individual features of plumage pattern, molt, and color (including soft-parts), categorized by overall appearance (“gestalt”) in California Brown Pelicans (*Pelecanus occidentalis californicus*) was used to estimate age-structure in samples from different stages of the annual cycle, over a series of years, and representing “normal” and depressed overall meta-population breeding success, including several years of extreme sub-optimal breeding associated with unusual SST warming. Known-age pelican gestalt was projected to age-estimated individuals sampled over the study period, comprising thousands of individuals. This application indicated that “gestalt categorization” was a suitable proxy for age up to the attainment of full-adult appearance (3 to 4 years of age). We illustrate some of the relationships being tested that evaluate seasonal and behavioral considerations and then age-structure/demography evaluations. Large, range-wide samples taken during mid-post-breeding dispersal and early-winter periods appear to be the most representative of meta-population, N-1 (previous breeding season), breeding status. Observations at only or a few local roosting sites carry different insights and also indicate considerable potential short- and long-term variation in local roost-use patterns. In other periods of the annual cycle, “gestalt sampling” tells different stories, i.e., proportions of adult-plumaged birds at major breeding colonies approximate annual adult breeding effort. Younger age-classes at breeding colonies in greater proportions at mid- and late-breeding phenology indicate a likelihood for higher overall breeding success attainment (thank you David Lack).

POPULATION GENETICS OF THE BAND-RUMPED STORM PETREL (*OCEANODROMA CASTRO*),  
ENDANGERED AND ENIGMATIC HAWAIIAN SEABIRD  
(Poster Presentation)

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The Hawaiian Band-rumped Storm Petrel (*Oceanodromo castro*), listed in 2016 as federally Endangered, nests in locations that are difficult to access and spends most of its life at sea. As such, very little is known about movement among islands and the potential for establishing new breeding colonies in managed areas with predator controls. As a first step in assessing connectivity, in this study we evaluated patterns in genetic diversity between populations on two islands known to host breeding populations. Blood or feather samples were collected from breeding colonies on Kauai and Hawai'i Island. Kauai and Hawai'i Island represent the northern and southern extent of the main Hawaiian Islands, and are approximately 300 miles apart. We performed next-generation sequencing on pooled samples from each island. Results suggest minimal differences among populations, as well as population contraction in recent history, which is not surprising, given the relatively recent introduction of nonnative predators and humans, which likely led to a decline in population numbers over the previous centuries. Findings from this study may be used to inform seabird conservation efforts and provide insights on population connectivity in long-lived taxa.

THE SEABIRD PARADOX: PROBABILITY, WING LOAD, OR COLONY ATTRIBUTES?  
(Oral Presentation)

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Within long-lived colonial seabird species there are competing pressures to either disperse or return to natal colonies. The behavior of returning to the natal breeding ground, philopatry, usually guarantees resources and mates, but also increases the potential for inbreeding, competition, and ecological traps. Thus, the high degree of philopatry among seabird species, coined the seabird paradox, is surprising, given their dispersal capabilities. Under a probabilistic model, a proportional rate of return to the natal colony is expected, but the number of colonies, colony size, and space between colonies may also influence rate of return. Additionally, wing load, linked to the ability to fly long distances, a central or non-central foraging strategy, and region may influence natal philopatry. We determined whether seabirds returned to their natal colony at rates greater than those predicted by these variables, based on long-term banding data of 36 seabird species from the Bird Banding Laboratory and British Trust for Ornithology, along with census data. Our results suggest that philopatric rates are significantly different from those expected based-on a probabilistic model, and differ between tropical and temperate colonies. Our review clarifies results found in previous studies, which did not examine null probabilities based-on the relative proportion of individuals in each colony, and identifies potential environmental predictors of philopatry.

## DRONES AS NON-INVASIVE TOOL FOR OBSERVING ABUNDANCE CHANGES OF SEA BIRDS IN MANGROVE AREAS

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Mangroves provide sites for resting and reproduction for sea and water birds. The observation and monitoring of birds in mangrove areas tends to have an important bias due to the difficulty of access. The use of drones for environmental studies and faunal monitoring in areas of difficult access has revolutionized ecological studies. The main goal of this work is to describe the temporal changes of waterbird abundance during 2016, in a mangrove immersed in the urban sprawl. Using a drone as a non-invasive monitoring tool, we have performed a census of birds in a mangrove area located southwest of the Gulf of California. The use of photographs taken from the drone has demonstrated to be a powerful tool for monitoring and tracking the abundance changes on water birds that use the mangroves as resting and breeding areas. A total of eleven species were identified: *Eudocimus albus*, *Ardea herodias*, *Bubulcus ibis*, *Egretta rufescens*, *Plegadis chihi*, *Ardea alba*, *Egretta caerulea*, *Egretta thula*, *Egretta tricolor*, *Nycticorax nycticorax* y *Burotides virescens*; being *E. albus* the most observed during the year, some of these species were observed on nests.

ABUNDANCE AND TEMPORARY VARIATION OF A FUNCTIONAL SEABIRD: THE RED-NECKED PHALAROPE (*PHALAROPUS LOBATUS*; AVES: SCOLOPACIDAE) IN THE GUERRERO NEGRO SALTWORK, B.C.S., MÉXICO

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During the migratory period, Red-necked Phalarope (*Phalaropus lobatus*) use the artificial wetland generated by Exportadora de Sal (ESSA) for salt production, located in Guerrero Negro, B.C.S, Mexico, as a stopover site to feed and rest. In ESSA, the Red-necked Phalarope is the most abundant shorebird. We describe patterns of habitat use and phenology of Red-necked Phalaropes in eleven seasons (2006-07 to 16-17). The abundance in ESSA varied in relation to month ( $F_{11,120}=30.75$ ,  $p<0.01$ ). The wetland is mainly used during autumn migration, with a slight increase in spring. Within ESSA, there is differential use between areas of differing salt concentrations ( $F_{11,440} = 30.11$ ;  $p<0.01$ ); the most important areas were 5A followed by 5B, whose salinities range from 105 to 120 UPS. Maximum abundances have increased significantly ( $F_{1,9} = 10.58$ ;  $p < 0.01$ ), from 20,000 (2006-07) to 79,000 individuals (2016-17). In order to understand these changes, abundances were related to a principal component generated from a combination of the Pacific Decadal Oscillation index, sea surface temperature, and Chlorophyll-a from the surrounding natural zone (Sebastián Vizcaíno Bay). A significant relation was observed ( $F_{1,20}=8.91$ ,  $p<0.01$ ). In 2006-07, 92 individuals were caught during the fall. The first individuals to reach ESSA were adults (July), followed by juveniles (August), reaching similar proportions at the end of the autumn migration (September). These results indicate the increasing importance of ESSA as an apparent response to large-scale environmental modifications.

## SEABIRDS OF PACIFIC MEXICO: DIVERSITY, DISTRIBUTION, AND ABUNDANCE

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The Pacific Ocean within Mexico's jurisdiction includes shelf, slope, and oceanic habitats in temperate and tropical latitudes. These waters support remarkably productive marine ecosystems but relatively few (though significant) seabird breeding colonies. We conducted at-sea surveys for seabirds in the greater eastern Pacific as part of a larger program of NOAA-based cetacean and ecosystem assessment surveys. These surveys included comprehensive coverage of Mexican waters during Aug-Nov, in 10 separate years, between 1988 and 2006. Two simultaneous strip transect surveys were conducted, one using handheld binoculars with a strip width of 300 m, and a second using high-powered (mounted 25x) binoculars with a strip width of 10 km. These data provide an unprecedented opportunity to investigate the seabirds of Mexico. Here we give an overview of species diversity, distribution, and abundance of seabirds in Mexican waters, and provide insights into changes in these metrics over time. Mexico's Islas Revillagigedo are of particular relevance at this time, as they were recently protected as Mexico's largest marine reserve in the form of the Revillagigedo Archipelago National Park. Our data can contribute to an evaluation of the significance of this effort.

## APPLICATION OF AUTO-REGRESSIVE STATE-SPACE MODELS TO ESTIMATE POPULATION TRENDS AND OBSERVATION ERROR FROM SEABIRD COLONY COUNTS

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Seabird colony counts conducted via land, sea, or air (and, increasingly, with UAVs) are widely used to estimate change in abundance. Such counts are often implicitly assumed to be a consistent index of population size, and population size is estimated via ad-hoc correction factors for unobserved individuals, or error distributions are assumed without evaluation of alternatives, despite potential limitations of these approaches. We compared these alternatives to autoregressive state-space (ARSS) models that attempt to separate the observation process (by estimating the observed proportion of the population) from the ecological process (by estimating population growth rate) using a combination of seabird colony count time series and simulations. We developed and analyzed time series of Common Murre (*Uria aalge*) attendance at 13 colonies and Brandt's Cormorant (*Phalacrocorax pencillatus*) attendance and nests at 8 colonies over the interval 1989-2014, in a study region spanning 350 km in far northern California that included ca. 40% of California's breeding seabirds. Across a range of real and simulated scenarios, ARSS models with truncated normal observation error often outperform other commonly-used models with normal observation error, likely due to the nature of whole-colony counts of seabird abundance (i.e. overcounting does not frequently occur, while undercounting is the rule). We applied this approach to estimate the distribution of stochastic population growth rates and the effect size of a phenomenon (the El Niño Southern Oscillation) widely thought to affect seabird population growth rates in California, and found the Southern Oscillation Index negatively affects murre and cormorant population growth rates.

## AVIAN DISTURBANCE AND PREDATION AT THREE CENTRAL CALIFORNIA COMMON MURRE COLONIES

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In central California, coastal colonies of Common Murres (*Uria aalge*) are impacted by avian disturbance and depredation. To better understand these impacts, we conducted surveys in 2017 at three colonies: Point Reyes Headlands (PRH), Devil's Slide Rock (DSR), and Castle Rocks & Mainland (CRM). Here, we report results from 2017 and compare to surveys from 1999-2001. Surveys were conducted in two hour segments between 0600-1800 h from mid-April to early August. Any avian disturbance event that caused agitation, displacement, flushing or depredation of murre adults, eggs or chicks was recorded. In 2017, 402 avian disturbance events were recorded. The greatest disturbance rates (seabirds disturbed/hour and disturbance events/hour) occurred at PRH where Turkey Vultures, Western Gulls and Common Ravens caused the most disturbances. Also, several chicks were depredated by ravens and gulls. The rates of disturbance at PRH appeared to be lower than in 1999-2001, when ravens and Brown Pelicans were the main disturbance sources. The highest rates of flushing events were from ravens at DSR, with high egg depredation rates. In 1999-2001, gulls caused the greatest rates of disturbance at DSR with no nest depredation. Disturbance rates at DSR appear to have been greater in 2017 than any year in 1999-2001. At CRM in 2017, gulls caused the greatest rates of disturbance but no nest depredation was observed during surveys. In 1999-2001, gulls and pelicans caused the most disturbances at CRM. Despite avian disturbance and depredation, breeding success was relatively high at all three colonies in 2017. However, raven disturbance and depredation is a concern for the recently restored DSR murre colony.



## SEABIRD RESTORATION ON THE BAJA CALIFORNIA PACIFIC ISLANDS, MEXICO: A FIVE-YEAR BINATIONAL AND MULTINSTITUTIONAL EXPERIENCE

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Oil and pesticide pollutants, invasive plants and animals, exploitation of natural resources, and climate change have negatively impacted seabirds along the Pacific Ocean off California, USA and Baja California, Mexico. An interdisciplinary team of scientists and conservation managers from multiple institutions and agencies, both from Mexico and the USA, have pulled together human and financial resources, and worked for the past five years on a group of seven key islands off the Baja California Peninsula to restore breeding seabird colonies of diurnal and nocturnal species. The project responds to the Montrose Settlements Trustee Council and the S.S. Jacob Luckenbach Trustee Council comprehensive approach to restore seabird species of binational interest. The Mexican NGO Grupo de Ecología y Conservación de Islas, A.C., has taken the leadership in the coordination and successful implementation of the project. We present the lessons learned, multiple techniques applied, outcomes, and recommendations for future projects not only in the region but elsewhere. Results are encouraging: some extirpated seabird species have recolonized several islands, numerous colonies have increased reproductive success, and new breeding colonies have been established. Moreover, we have updated a vast knowledge gap in the status of seabirds. Long-term funding has been a challenge for monitoring large colonies on these seven islands. Also, adverse natural climatic conditions (e.g., El Niño-Southern Oscillation) affected planned recovery actions. The development of specialized capacities, dedicated team of skillful and experienced staff, and the persistent collaboration with government agencies and fishing cooperatives have been key to the project's success.

## A NATIVE MUSTELID'S ROLE IN SEABIRD CONSERVATION ON HAIDA GWAI

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Zoogeographic data from the archipelago of Haida Gwaii, British Columbia, where 50% of the global population of Ancient Murrelets (*Synthliboramphus antiquus*) come ashore to breed, suggest that native Pacific Marten (K'uuxuu, *Martes caurina*) are providing a valuable ecological service by preventing rats (Kaagan, both *Rattus rattus* and *R. norvegicus*) spreading to offshore islands where seabirds nest. However, marten do not occur on any small islands in the archipelago, and many of these small islands therefore act as source islands for rat populations that continually threaten globally significant seabird colonies that occupy the most remote islands. We present results of 7 years of camera trapping data that have revealed mammal communities on over 90 islands. These data have led to the idea that K'uuxuu may be used to suppress or eradicate rats on small islands where seabirds do not breed, islands that are never prioritized for eradication by traditional techniques (poison) because of the high cost and lack of tangible ecological gains on such islands. We elaborate a Proof of Concept study to test this idea, and invite critical comments from the seabird community.

## MODELLING BYCATCH RATES TO ESTIMATE MORTALITY OF ALCIDS IN BRITISH COLUMBIA COMMERCIAL SALMON GILLNET FISHERIES

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Incidental take of marine birds in fisheries is an international conservation concern, including Canada where globally significant populations of diving species overlap with gillnet fisheries. In British Columbia, estimates of gillnet bycatch of marine birds are limited in space and time. While historically high (>200,000 d fished annually in the early 1950's), commercial salmon gillnet fishing effort in British Columbia has declined substantially. Observations of seabird bycatch within the commercial fishery, however, are limited in area, scope (<1% of annual effort) and are available only for 1995 onwards. Using observer data from commercial, and test fisheries (1995-2016), we developed models to estimate seabird bycatch rate in gillnet fisheries (number of marine birds captured per set) employing a Bayesian approach, with observer data post-stratified by fisheries sub-management area, target species and year. Using estimates of total fishing effort (estimated number of sets, 2001-2016) we applied the rate model to extrapolate annual take for the main bird species (or groups) of interest. Multinomial probability estimates of species composition were calculated based upon the available information (n= 887 birds identified to species), enabling estimates of potential numbers of Common Murre (*Uria aalge*), Rhinoceros Auklets (*Cerorhinca monocerata*), Marbled Murrelets (*Brachyramphus marmoratus*) and other seabirds captured annually (with CVs) in gillnet fisheries throughout British Columbia. Modelling bycatch of seabirds in gillnet fisheries is needed to investigate impacts on population trends, and potentially to inform mitigation options, particularly for the Marbled Murrelet, listed as Threatened in Canada.

## PREDICTING PREDATOR HOTSPOTS IN ATLANTIC CANADA USING SPATIALLY MODELLED SPAWNING HABITAT OF THE DOMINANT FORAGE FISH SPECIES, CAPELIN (*MALLOTUS VILLOSUS*)

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In the Northwest Atlantic, capelin (*Mallotus villosus*) is the dominant forage fish species that many top predators, including seabirds, rely on as prey. In coastal Newfoundland, capelin commonly spawn at near-shore, intertidal sites, but have been recently observed spawning in deeper water (14–40 m). These deep-water spawning sites persistently attract high abundances of top predators (e.g., marine mammals, groundfish, and seabirds), thus creating predator ‘hotspots’. Unfortunately, little is known about the spatial extent of coastal deep-water spawning sites in Atlantic Canada because of their recent discovery. The goal of this study was to predict areas that are likely to be predator hotspots by modelling the spatial extent of potential deep-water spawning habitat in areas of high seabird densities. Previous studies identified temperature, depth, bathymetry and sediment size parameters that characterize annually persistent deep-water spawning habitat. We used ArcGIS to overlay spatially-referenced physical data layers to model the locations of potential deep-water spawning habitat using the spatial overlap of suitable physical features. By further overlaying existing spatially-referenced seabird density layers from breeding population estimates, we identified the location of potential predator hotspots. The results of this study can serve as an important baseline for tracking climate change associated habitat distribution shifts; furthermore, delineating capelin-seabird hotspots can support the designation of networks of marine protected areas to conserve capelin population resiliency along with the seabird populations that depend on capelin as their primary food source.

## SOUNDSCAPES TO MEASURE SEABIRD RESTORATION OUTCOMES IN THE WESTERN ALEUTIAN ISLANDS

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Iterative improvements in conservation practice require a robust understanding of conservation outcomes. However, measuring outcomes can be challenging and expensive, particularly on islands. Automated acoustic sensors can significantly increase the spatial and temporal scale of outcome measurements while potentially reducing data collection costs. However, data analysis remains an obstacle; reliance on a limited number of species detection analytical tools, with a priori assumptions and laborious review of automated detections limits analytical efficiency. By contrast, a soundscape approach, where ecological communities are characterized using acoustic indices considers the entirety of the acoustic environment, is data-driven, and requires significantly less a priori decision making. We analyzed 4,970 ten-minute recordings of nocturnal seabird soundscapes from four Western Aleutian Islands, where introduced predators had devastated seabird island ecosystems but were subsequently removed 9-34 years ago; and from one invaded and one uninvaded reference island. We calculated eleven indices characterizing acoustic intensity and complexity, and three pairwise measures of acoustic similarity. On restored islands, we found indices of acoustic intensity increased with time since eradication, as did similarity to the uninvaded reference island. Our results indicate that soundscape differences can be used to monitor outcomes of seabird restoration more quickly and cheaply than other approaches.

## SEABIRD RESTORATION ON THE BAJA CALIFORNIA PACIFIC ISLANDS, MEXICO: MULTIPLE AGENCIES, TRUSTEE COUNCILS, U.S AND MEXICO ORGANIZATIONS COLLABORATING FOR SUCCESS

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In 2013, The Montrose Restoration Program and the Luckenbach Oil Spill Trustee Councils embarked on an ambitious five-year \$4M restoration project to restore seabird populations of the Baja California Islands, Mexico. Following a request for proposals, funding was awarded to organizations from the U.S. and Mexico, including the, Grupo de Ecología y Conservación de Islas (GECI), the Mexican Fund for the Conservation of Nature (FMNC), National Audubon Society, and Cornell Lab of Ornithology to complete the program. The goal of the program is to compensate for seabird species injured by DDT and PCB contamination released by the Montrose Chemical Corp and affected by oil released from the sunken tanker S.S. Jacob Luckenbach.

Restoration activities included using social attraction techniques (including decoys and vocalizations), improving nesting opportunities with artificial nests, biosecurity, bioacoustics monitoring, and reducing human disturbance and involvement of local communities through environmental learning, art and outreach. The target species for restoration on these islands are Brandt's Cormorant, Double-crested Cormorant, Pelagic Cormorant, California Brown Pelican, Western Gull, Cassin's Auklet, Ashy Storm-Petrel, Black Storm-Petrel, and Scripps's Murrelet. This program serves as an example of a highly successful collaboration of two natural resource damage trustee councils and U.S. and Mexican organizations. It is the largest international project funded to date by funds from natural resource damage settlements. We will present some of the results and outcomes of this project with suggestions to guide future binational collaborations on natural resources share by the two countries.

## BREEDING DISTRIBUTION, POPULATION STATUS AND PRODUCTIVITY OF THE BROWN PELICAN ON MEXICAN PACIFIC ISLANDS

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The populations of Brown Pelican (*Pelecanus occidentalis*, BRPE) in the Pacific Ocean were severely affected by oil and pesticide pollutants during 1950 and 1960. In Mexico, conservation efforts for this threatened species have included the removal of all invasive mammal species from its breeding colonies in the Mexican Pacific. However, demographic trends have been not currently evaluated in the region. Since 2013, as part of a binational and multi-institutional seabird restoration and monitoring program, we have evaluated the current range distribution, number of breeding pairs, reproductive performance, breeding phenology, diet and threats in eight Baja California Pacific islands. Moreover, we started a banding program in 2015. We have registered regional and inter-annual fluctuations along these five years: main breeding colonies are located on the northernmost islands; breeding population size and productivity have varied from very low numbers in 2014-2015, when anomalous warm water conditions affected the region, to high estimates in 2016-2017; and timing of breeding have showed a latitudinal trend all years. Preliminary results on diet samples show anchovy and sardine are valuable resources for this specialist species, and banding program has given relevant information about movements and survivorship of fledglings. This binational collaboration has generated relevant results and identified conservation priorities to continue working together for the restoration of the BRPE and all seabird species in this priority region.

## ARE MURRES SOCIAL FORAGERS?

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The Thick-billed murre (*Uria lomvia*) is one of the most common seabirds in the Arctic, and forms both the biggest and the densest colonies of all seabirds. However, the exact reason why it forms such big aggregations during reproduction is still open to speculation. While predation defense seems to provide an advantage to the highly social seabird, it doesn't explain the formation of million-bird colonies. We studied the synchronisation of thick-billed murres returning to the nest to find presence of social foraging. We also looked at feeding rate and growth of chicks when colony size differed, to look for advantages of big aggregations when feeding. Our results suggest that murres actively form groups when foraging, and that a more populated colony favours social feeding. Enhanced feeding success through group foraging could then provide a good explanation as to why thick-billed murres form such large colonies.



## CONSEQUENCES OF WING ASYMMETRY OF FOUR HYDROBATIDAE IN THE NORTH MEXICAN PACIFIC OCEAN

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Wing asymmetry could be an important component of flight costs for seabirds. Hydrobatidae nesting in the San Benito Islands of the North Mexican Pacific Ocean were measured and analysed to study wing asymmetry. Wing length (b m), and wing loading ( $Q \text{ Nm}^{-2}$ ) of 68 *Oceanodroma* spp. were measured. To establish asymmetry, we measured partial wing length, from the wing base to the wing tip of each wing. Means and standard deviations were used to statistically compare variance differences between left and right wings. No statistically significant differences ( $p > 0.05$ ) were found for wing asymmetry and the estimates of flight costs for the *Oceanodroma* spp. studied of the Mexican North Pacific. Nonetheless, the data distribution graphs show a trend in wing asymmetry: all species' left wings are longer, with smaller variances for *O. melania* ( $L = 4.40 \text{ cm}^{-2}$ ,  $R = 5.87 \text{ cm}^{-2}$ ), and higher variance for left wings in *O. leucorhoa* ( $L = 1.85 \text{ cm}^{-2}$ ,  $R = 1.67 \text{ cm}^{-2}$ ), and *O. microsoma* ( $L = 1.55 \text{ cm}^{-2}$ ,  $R = 1.40 \text{ cm}^{-2}$ ). We can demonstrate differences in  $Q$  between wings of our flight costs approximation *O. melania*  $0.008 \text{ N}\cdot\text{m}^{-2}$ , *O. leucorhoa*  $0.007 \text{ N}\cdot\text{m}^{-2}$ , and *O. microsoma*  $0.011 \text{ N}\cdot\text{m}^{-2}$ . These measures could be pointing to constant selective pressures such as dominant winds, or earth rotation effects. Further analyses should increase both sample size and taxonomic variability, and Bayesian analysis could facilitate hypothesis testing.

PHYLOGENETIC RELATIONSHIP BETWEEN THE AINLEY'S STORM-PETREL (*OCEANODROMA CHEIMOMNESTES*) AND THE TOWNSEND'S STORM-PETREL (*O. SOCORROENSIS*)

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The Leach's Storm-Petrel (*Oceanodroma leucorhoa*) previously included four subspecies. However, the subspecies *O. l. cheimomnestes* and *O. l. socorroensis*, that breed exclusively on Guadalupe Island, Mexico, were elevated to species level by The American Ornithologist's Union in 2016. This new taxonomic classification was based on differences in reproductive chronology, morphometric measures, coloration, and vocalizations. Nevertheless, this change was established without previous phylogenetic studies. In order to provide elements to corroborate this assignment, we analyzed the variation in three mitochondrial genes (control region, COI and cytochrome b) in breeding individuals of the Ainley's Storm-Petrel (*O. cheimomnestes*) and the Townsend's Storm-Petrel (*O. socorroensis*) on islets of Guadalupe Island. Additionally, we used stable isotopes analysis of carbon and nitrogen to evaluate the isotopic niche during the breeding season. For this, we collected blood samples from both species between 2014 and 2016. The genetic distances revealed that these species fell within the subspecies intervals (0-3.9%). Although we found genetic structure ( $\phi_{ST} = 0.25$  and  $F_{ST} = 0.08$  p <0.005) and differences in isotopic niche between both species; the phylogenetic trees and the haplotype network indicate they are conspecific and gene flow exists. Based on our results, we recommend considering them as subspecies.

CHILEAN PURSE-SEINE FISHERY OVERLAP AND RISK OF BYCATCH AMONG PINK-FOOTED SHEARWATERS *ARDENNA CREATOPUS* BREEDING ON ISLA MOCHA

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The Pink-footed Shearwater, (*Ardenna creatopus*), is listed as Vulnerable by the IUCN, with an estimated world population of 59,000 birds. In Chile, >1000 Pink-footed Shearwater mortalities were documented during 2015–2016 in semi-industrial (“artisanal”) and industrial anchoveta (*Engraulis ringens*) and sardine (*Strangomera bentincki*) purse-seine fisheries. We GPS tracked chick-rearing Pink-footed Shearwaters breeding on Isla Mocha, Chile, during February–March 2015–2017 ( $n = 15–18$  birds annually). We combined bird tracking data with purse-seine fishing effort data from central Chile from 2005–2016 to identify zones with greatest bycatch risk. During all years, shearwaters used continental shelf and shelf-break habitats exclusively within Chilean territorial waters, generally less than 30 km offshore. A consistent inter-annual foraging “hotspot” was located south of Isla Mocha, offshore near Valdivia, Chile (approximately 39–39.5°S), with especially high bird use during 2015 and 2016. During 2017, more birds traveled north, with the majority of use centered in the Gulf of Arauco (around 37.0°S). Shearwater foraging areas overlapped extensively with purse-seine fisheries. Across all bird-tracking years, areas of greatest bycatch risk in artisanal fisheries were near Valdivia, in the Gulf of Arauco, around Isla Mocha, and offshore of Talcahuano, Chile. For industrial fisheries, risk was greatest near Valdivia, around Isla Mocha, and north of Talcahuano. Additional tracking is needed during other life-stages to better inform collaborative efforts to reduce bycatch.

## PRIOR FORAGING SUCCESS AND DYNAMIC HABITAT QUALITY MEDIATE SHORT-TERM FORAGING SITE FIDELITY IN A SEABIRD

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Foraging site fidelity allows animals to increase their efficiency by returning to profitable areas, but can be maladaptive in unpredictable environments. Here we explore how variable habitat quality and prior prey capture success influence short-term site fidelity by a marine predator, the little penguin (*Eudyptula minor*). We found that penguins exhibited higher site fidelity after foraging trips where environmental conditions were favourable and prey capture success was high. When penguins exhibited low site fidelity, their success relative to the previous trip increased, suggesting that large switches in foraging location were an adaptive strategy in response to unfavourable conditions. Penguins also foraged closer to where other penguins foraged on the same day than they did to the location of their own previous foraging site. For every kilometre closer together penguins foraged on the same day, the mean number of prey captures increased by 9 %, suggesting that penguins aggregated flexibly when prey was abundant and accessible. Our results illustrate how foraging predators can integrate information about prior experience with contemporary information such as social and environmental cues. This gives insight into how animals combine information adaptively to exploit changing prey distribution in a dynamic environment.

## NON-BREEDING SHEARWATER INTERACTIONS AND RESPONSES TO SUPPLEMENTAL FOOD DURING VARYING PREY AVAILABILITY

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Multiple predator species tend to concentrate in areas where prey aggregates and, thus, competition may occur if resources become limited. Competition occurs when individuals directly interact to prevent each other from exploiting resources (Interference), or when individuals do not directly interact but respond to a decreased level of a limited resource after exploitation by others (Exploitative). In Newfoundland, capelin (*Mallotus villosus*) is the main forage fish, upon which most top predators rely as prey. Capelin migrate inshore to spawn during the summer and then offshore after spawning, transforming prey availability from unlimited to limited in coastal regions. The objective was to investigate the interactions and responses of non-breeding great and sooty shearwaters (*Ardenna gravis* and *A. grisea*) to supplemental food under changing prey availability. We conducted an at-sea experiment during the summer (2015-16) during unlimited and limited prey, whereby cod liver was offered every 30 s over 10 min from a small boat. The number of both species was higher under limited relative to unlimited prey availability. Although direct interactions between species were not observed, great shearwaters were close (<2 m) to the boat and directly competed for cod liver with other species (e.g. gulls). In contrast, sooty shearwaters were farther (>10 m) from the boat and never directly competed for liver. Instead, they dived more often, possibly to avoid direct interactions. These findings suggest that both species relied more on supplemental food were prey were limited and that great shearwaters displayed more competitive and aggressive behaviour, possibly displacing sooty shearwaters from this supplemental food source.

## RADAR AS A TOOL TO MONITOR ELUSIVE AND NOCTURNAL SEABIRD SPECIES

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Radars can be used for detecting birds moving at night, when visual observations cannot be used, and can provide precise information (direction, speed, altitude) of individuals in flight.

Furthermore, radars can detect birds at long distances and can thus provide an important tool to detect birds in areas difficult to reach. In this study we used an X-Band radar to investigate the movements of Grey Gulls (*Leucophaeus modestus*) close to a colony. This gull is a medium sized species that forages along the coast of Northern Chile and Southern Peru. Differently from other marine birds, however, it does not breed close to the sea but rather in remote areas of the Atacama Desert, several tens of km away from the sea. The gulls perform their commuting flights between the colony and the coast mostly at night, probably for predatory avoidance. Therefore, although its breeding colonies can count up to several thousands of pairs, they are difficult to detect and during the breeding season 2016-2017 only one single active colony was known. We monitored with a radar the movements of the birds at this colony to investigate their hourly routine and we could reveal a bimodal pattern in their nocturnal movements from and to the colony. In addition, by extending the range of detection we used the radar to locate new potential colonies in other areas of the desert. We noticed birds heading to different areas and by triangulating their trajectories from different radar locations we could detect other colonies of several thousand pairs in a remote area difficult to reach otherwise.

## IMPORTANCE OF THE STATE ECOLOGICAL PARK LAGUNA COLOMBIA "PUNTA SUR" FOR THE TERNS CONSERVATION IN COZUMEL

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The State Ecological Park Laguna Colombia "Punta Sur" is one of the five protected natural areas that Cozumel Island have, with a total area of 2793 acres and it is located in the south-eastern zone of the island. Punta Sur is characterized for having different types of ecosystems that are the habitat of hundreds of species as well as endemic fauna of the island; it specifically protects important colonies of aquatic and marine birds, as well as migrant, permanent and passerby birds. Punta Sur Park still has its natural characteristics which made it an appropriate site for nesting of several species of marine birds that are under protection like the Least Tern (*Sternula antillarum*) that comes to breed each year on the beaches and shores of the Laguna Colombia, the Roseate Tern (*Sterna dougallii*) that was recorded nesting for the first time in June of 2016 within Punta Sur making it the second record for Mexico and the Bridled Tern (*Onychoprion anaethetus*) that has been reported to nest on different years. Furthermore, other species of sternula can be found like the Royal Tern (*Thalasseus maximus*), Sandwich Tern (*Thalasseus sandvicensis*) and The Gull-Billed Tern (*Gelochelidon nilotica*) have used the park for resting and feeding during the migration season.

## CORMORANT COUNTING: HARRY CARTER'S LEGACY IN THE SALISH SEA

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Harry Carter and I became fascinated with seabirds as summer students working for the Province of BC. We began surveying seabird colonies in the late 1970s and continued documenting the up's and down's of cormorant populations until the present. Harry was particularly good at finding historical records for seabirds, and he documented Double-crested Cormorants in Salish Sea colonies since the 1800s, which correlates with archaeological records of First Nation middens.

Harry encouraged us to re-survey and analyze trends for cormorant colonies in the Strait of Georgia (Canadian portion of the Salish Sea) over six decades (1955 to 2015). We found Pelagic Cormorant and Double-crested Cormorants fluctuated widely over this period, and estimate that ~ 1400 breeding pairs of Pelagic Cormorants and ~700 breeding pairs of Double-crested Cormorants currently nest in the Strait of Georgia. Most currently nest on Mandarte Island, Mitlenatch Island, and the bridges in Vancouver. The main factors causing decline after 1987 are increased predation by Bald Eagles, availability of forage fish prey, and human disturbance. Harry was also part of team that discovered Brandt's Cormorants nesting on Mandarte Island, marking a return of this species that had nested in the Strait of Georgia since the 1980s.

Harry encouraged a group of us to re-survey all Double-crested Cormorant colonies in the Strait of Georgia in 2017. This work will contribute to management of cormorants in western North America, especially in relation to cormorant control in the Columbia River estuary and bridge nesting sites in Vancouver.



## IMPLEMENTATION OF BYCATCH REDUCTION PLANS IN CHILEAN FISHERIES

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Aware of the negative impacts of bycatch for the long term sustainability of fisheries, Chile amended its Fisheries Act in 2012, introducing new regulations on bycatch, and establishing sanctions and control measures for those incurring in such practice. However, before penalizing bycatch, the law required the development of research programs to identify and quantify this issue, recognize the causes, and propose mitigation measures. Previous legislation just banned bycatch and applied strong sanctions, converting bycatch in a taboo topic within fishermen. Therefore, these studies involved technical and cultural challenges to achieve fishermen support. To obtain (behaviorally) unbiased information, during these studies, sanctions on bycatch were suspended. Originally, the information had to be collected exclusively by fisheries observers, but because of coverage restrictions, fishermen were also incorporated through self-report. Observer programs were improved through regulations on working conditions, training, safety, and data collection. In addition, an intense socialization program was deployed in the field to introduce these programs and achieve the fleet's commitment. Guides for fishermen, workshops and field meetings along with a strong injection of budget, reaching US \$2 M in 2017, were also provided. By 2017, four programs have been concluded, including purse seine fisheries, and binding mitigation plans have been enacted. These were discussed with fishing users at the Management Committees and include measures, technological media, a surveillance, control, and vigilance program, training and codes of conduct. Since Chilean observers do not monitor compliance, EMS will monitor and control bycatch onboard.

## ECOLOGY OF AN INCREASING POPULATION OF CASSIN'S AUKLETS AT AÑO NUEVO ISLAND

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Island habitat in central and northern California is limited, offering few opportunities for range expansion of breeding seabirds. We describe the colonization of a nearshore central California seabird colony, Año Nuevo Island, by Cassin's Auklets (*Ptychoramphus aleuticus*). We quantify population, reproduction, mortality, band returns, and habitat quality metrics at Año Nuevo Island from 1995-2017. After colonization of Año Nuevo Island in 1995, Cassin's Auklet population grew to at least 40 birds in 2004, then declined for several years until 2008, after which it grew rapidly to 136 birds in 2014. Overall, there was a significantly increasing population trend from 1994-2017. Average annual productivity values were  $0.79 \pm 0.09$  (2011-2017) including double clutches. Limited band returns of nesting birds indicated breeders originated from both Southeast Farallon Island and Año Nuevo Island. The observed adult and chick mortalities at this colony included avian depredation (Western Gulls and birds of prey) and burrow collapse. Plant restoration, erosion control material, and artificial clay nest modules have mitigated the severity of erosion damage to nests. The percent of occupied burrows damaged by erosion was  $14 \pm 8\%$  (2011-2017). Population and reproduction metrics studied at Año Nuevo Island provide unique information about a recently colonized, and increasing, Cassin's Auklet breeding population.

## TOP-DOWN AND BOTTOM-UP INTERACTIONS INFLUENCE FLEDGING SUCCESS AT NORTH AMERICA'S LARGEST COLONY OF CASPIAN TERNS (*HYDROPROGNE CASPIA*)

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We investigated the influence of bottom-up and top-down drivers on the declining fledging success at a once thriving breeding colony of Caspian Terns (*Hydroprogne caspia*). Situated at the mouth of the Columbia River, Oregon, East Sand Island (ESI) is home to the largest Caspian tern breeding colony in North America. Between 2001 and 2011, the decline in fledging success of Caspian Terns at ESI was associated with a significant increase in average river discharge during May and June. High river discharge reduced both the abundance of marine forage fish in the estuary and their availability to terns and other predators as prey. This relationship influenced the reliance of tern nest predators (eagles and gulls) on the tern colony as a food source, including an increase in kleptoparasitism on terns by gulls, resulting in increased disturbance and decreased fledging success at the tern colony in years of higher river discharge. Predictions of relatively low nesting success in years of high river discharge and the converse have been borne out in succeeding years (2012-2017). Just as the unprecedented river flows during the 2011 breeding season contributed to the first recorded complete failure to fledge chicks at this colony, river flows during the 2017 breeding season were the highest since 2011, and again there was a complete failure to fledge chicks. Our results support the hypothesis that annual variation in fledging success at this large estuarine colony of Caspian Terns is largely driven by the interaction of bottom-up and top-down factors, influencing tern fledging success through their food supply and triggering potential predators to focus on the tern breeding colony as an alternative source of prey.

## ESTIMATING BREEDING POPULATION SIZE OF A CLIFF-NESTING MARINE BIRD SPECIES

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Determining how to effectively monitor the breeding population size of a seabird species with cryptic nests presents a substantial challenge. Glaucous-winged gulls (*Larus glaucescens*) are a common marine bird species in and around Kenai Fjords National Park (KEFJ), Alaska that breeds in numerous colonies. We compared field counts to replicated photographic counts collected over 2-4 days at seven colonies in the KEFJ area. High variability in both count methods precluded precise abundance estimates, so we developed an intensive method of analyzing images using a mark-resight (MR) approach to identify potential nesting locations. We used a Bayesian approach to estimate the number of locations that were most likely to be nests. We also investigated temporal and environmental factors likely to affect attendance, and thus our measures of abundance. Our broad conclusions were that our modified MR approach allowed us to estimate breeding abundance and addressed the variability inherent in repeated counts, and different factors affected attendance at locations likely to be nests compared to locations that were not. This work also produced specific considerations for monitoring this species in KEFJ: 1) repeat counts are always better than single counts, 2) photographs are better than field counts, 3) minimum counts most closely approximate the number of nests, and 4) minimum attendance at colonies is most likely to occur at low tide.

## DIVERSITY OF SEABIRDS IN THE SOUTHERN GULF OF MEXICO

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Seabirds provide important information for the analysis of oceans and aquatic environments by functioning as bioindicators. Knowing species diversity is a key first step in conservation and management strategies that minimize impacts on populations and marine resources. Although there are several studies of seabirds in the northern Gulf of Mexico, species diversity and distribution has not been studied in the southern region of the Gulf. The objective of this work was to assess the diversity and distribution patterns of seabirds in the southern Gulf of Mexico in 2016, comparing coastal and oceanic habitats, and dry (March) and rainy (September) seasons. We surveyed transects from the port of Veracruz to the northern tip of the Yucatan Peninsula aboard two oceanographic boats of SEMAR (Secretaría de Marina Armada de México). We recorded ten species of seabirds: Pomarine Jaeger (*Stercorarius pomarinus*), Laughing Gull (*Leucophaeus atricilla*), Royal Tern (*Thalasseus maximus*), Cabot Tern (*T. acuflavidus*), Magnificent Frigatebird (*Fregata magnificens*), Masked Booby (*Sula dactylatra*), Brown Booby (*S. leucogaster*), Red-footed Booby (*S. sula*), Doubled-crested Cormorant (*Phalacrocorax auritus*), and Brown Pelican (*Pelecanus occidentalis*). We found no significant differences of species diversity values between coastal and oceanic habitats nor between dry and rainy seasons, possibly because both species number and individual representation was similar. However, the species composition was different for each habitat and season. Species composition was different due to the distribution and feeding habits, migration, nesting site location, flight ranges, etc. Our work contributes to the scant data available on the southern Gulf of Mexico. We encourage future researchers to contribute even modest data to continue updating what we know of this region and enable the development of future projects of ecological interest.

## DISTRIBUTION AND ABUNDANCE OF BROWN PELICAN (*PELECANUS OCCIDENTALIS CALIFORNICUS*) IN THE GULF OF CALIFORNIA DURING FOUR RESEARCH CRUISES

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This study includes information on four cruises, on observations of sightings of the brown pelican (*Pelecanus occidentalis californicus*) in the Gulf of California. A total of 1,216 individuals were observed during 268 sightings in the field, generated during research cruises of the years 1985 and 1986. The data collected in situ of each observation (species, number of individuals, date, time, geo-reference, oceanographic and environmental parameters) were integrated and analyzed in a previously approved database. This information was subject to a review, debugging and correction process. Relative and absolute frequencies were estimated per transect in each of the surveys during the mentioned years. Frequencies were highest in the Midriff Island Region, an area characterized for its high primary production. These results were analyzed and areas compared using the ArcGIS tool 10.5, in order to identify areas of high and low species abundance. Also, information was divided in order to generate maps by date, in order to increase the information on the distribution of this seabird species in the study area and contribute to its better conservation, administration and management of this natural resource in Mexico and North America.

## SEABIRD INTERACTIONS AND CATCH IN ALASKA TRAWL FISHERIES – SUPPLEMENTAL DATA COLLECTION REVISITED

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Seabird bycatch in trawl fisheries is an extremely rare event and challenging to monitor and quantify using standard observer sampling methods for species composition. A pilot study in Alaska trawl fisheries from 2005-2009 indicated that the majority of seabird mortality occurs from gear interactions outside of the standard observer sample (e.g., cable interactions and net entanglements). Birds caught outside of the typical species composition sample are not currently included in the National Marine Fisheries Service estimates of birds caught. With this knowledge, in 2010 additional codes and forms were added to improve the collection of seabird catch data by the North Pacific Observer Program in Alaska trawl fisheries. In this study we compare seabird mortality rates from 2010-2015 using standard observer sampling with supplemental seabird mortality rates on trawl vessels among target fisheries, large geographic regions and processing types. We evaluate how well current protocols meet the needs of reporting supplemental seabird mortality on trawl vessels and provide recommendations to improve the current data collection. In general, catcher-processing vessels had higher seabird mortality rates than catcher vessels and rates were highly variable among target fisheries and large geographic regions. As in previous studies, catch outside of the typical observer sampling procedure contributed a substantial proportion of the total observed catch. We will also discuss options for improving fleet-wide seabird mortality estimation using the “supplemental sample” sources.

## WAS THE 2017 BREEDING SEASON A TIPPING POINT FOR MANDT'S BLACK GUILLEMOT IN ALASKA? AN ICE-ASSOCIATED SEABIRD CONTINUES TO STRUGGLE IN A MELTING ARCTIC

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Mandt's Black Guillemot (*Cepphus grille*) is one of the few truly pagophilic seabirds, occupying the Marginal Ice Zone of Arctic sea ice throughout the year. In 1972 a colony of ten pairs was discovered on Cooper Island, in the western Beaufort Sea off northern Alaska, with all nests in cavities provided by manmade debris. The colony has been studied annually since 1975 with investigator provisioning of new nest sites increasing colony size to 200 pairs in 1989. Since 1990, coinciding with a phase shift in the Arctic Oscillation that increased the rate of regional warming and melt, the Cooper Island colony has experienced a substantial decrease in breeding success and colony size, with 100 pairs breeding in 2016.

Fieldwork in the summer of 2017 found a continuation of the colony's past declines in numbers and breeding productivity but also revealed reductions in additional demographic parameters that could portend the beginning of a period of accelerated colony reduction. Only 85 pairs bred in 2017, the fewest since the early 1980s. For the first time in the four decades of study we saw a number of pairs that included at least one experienced breeder occupy nest sites but fail to lay eggs. Overwinter survival of breeding adults, which has averaged close to 90 percent over four decades, was approximately 75 percent. Nonbreeding birds, which prospect nest sites before recruiting to the colony in subsequent years, used to constitute up to a third of the birds in colony but were essentially absent in 2017. Early sea ice retreat north of the island and associated extremely high sea surface temperatures in July and August 2017, resulted in decreased availability of the preferred prey, Arctic Cod (*Boreogadus saida*), and the first occurrence of irregular availability of alternative prey during the period of chick provisioning, causing high nestling mortality. Breeding success was only 0.5 fledges per nest, half of what is needed to maintain a stable population. However, three breeding pairs were able to each fledge two chicks, indicating a small number of individuals are adapting to the ice-free subarctic conditions now present in late summer.



## APPLYING CHANGE DETECTION AND MULTI-SPECTRAL IMAGE PROCESSING TOOLS TO CENSUS NESTING ALBATROSSES FROM SATELLITE IMAGERY

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Globally, the IUCN lists all 22 species of albatross at some level of conservation concern. Of the three North Pacific albatrosses, the short-tailed albatross (*Phoebastria albatrus*) has an increasing population trend, black-footed albatross (*P. nigripes*) has a stable or increasing population, while Laysan albatross (*P. immutabilis*) have a decreasing population. In all cases, trends rely extensively on colony count data. With the availability of WorldView-3 satellite imagery in 2014, paired satellite and ground-based counts provide the calibration metrics necessary to assess inaccessible or particularly remote populations. Once calibrated, satellite image-based counts permit routine population assessment over large spatial scales. We apply two, separate image-processing techniques – linear spectral un-mixing and image subtraction – to Worldview-3 multispectral imagery, for images where reduced spatial resolution permits individuals from being counted directly. For panchromatic imagery, we use filtering techniques to improve manual and computer-based detection techniques. Preliminary results suggest that for low contrast applications, linear spectral un-mixing and image subtraction provide estimates that approximate ground counts. Panchromatic-based counts are a useful proxy of colony counts for short-tailed albatross and black-footed albatross when the background is highly contrasting. Satellite technology, combined with an increasingly large set of image processing tools and techniques, provide a novel and viable alternative to ground-based counts. Furthermore, producing abundance indices more frequently and over larger spatial scales will increase the statistical power of detecting population change over time.

## DIET OF RED-FOOTED BOOBIES PROVISIONING CHICKS ON O'AHU: AUGMENTED WITH GENETIC ANALYSIS

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The diet of Red-footed Boobies, (*Sula sula*) was quantified using 106 regurgitations collected opportunistically at Ulupau Crater, O'ahu, Hawai'i, from 81 adults during two years: 2014 (1–7 June) and 2015 (17 June–27 July). We sorted 1007 prey items into 3 categories: Fish, Squid, and Other (extremely digested “mush” and parasitic isopods). The average number of prey items per sample was  $8.1 \pm 5.7$  (2014) and  $10.6 \pm 8.4$  (2015). First, we assigned prey items a categorical freshness value: 1 (perfect condition), 2 (superficial digestion), or 3 (highly-digested and incomplete). Next, we measured sizes and took genetic samples from 492 items (freshness 1 and 2). 82% (n = 401) of those items were genetically identified. Rarefaction analyses revealed robust estimation of species richness in the diet which included 29 fish and 3 squid species. Moreover, 98.7% (232 of 235) of identified squids were Purpleback flying squids (*Sthenoteuthis oualaniensis*). Despite the dominance of fish in 2014 (%PSIRI fish 32.3%, squid 15.1%) and 2015 (%PSIRI fish 29.9%, squid 22.3%), diet composition varied significantly among the two study years. Squid were also significantly larger in 2015 ( $7.2 \pm 1.1$  cm) than in 2014 ( $6.3 \pm 1.7$  cm), indicating that differences in relative abundance and size may have been associated with El Niño conditions in 2015, similar to results from French Frigate Shoals (Seki & Harrison 1982). Altogether, due to Red-footed Boobies having opportunistic diets, we suggest they can be used to sample variability among epipelagic nekton assemblages during periods of contrasting oceanographic conditions.

PREDATION BY SEA DUCKS *MELANITTA* SPP. ON CULTIVATED MUSSELS *MYTILUS GALLOPROVINCIALIS* IN BAHÍA DE TODOS SANTOS, ENSENADA, BAJA CALIFORNIA, MÉXICO

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*Melanitta perspicillata*, the Surf Scoter, impacts on the *Mytilus galloprovincialis* mussel culture, in Todos Santos Bay. We studied the impact during the 2013-2014 wintering season. We assumed that mussel production could be impacted detrimentally by *Melanitta perspicillata*'s predation, causing economic losses to the producers. We estimated that *M. perspicillata*'s average abundance at the culture area was 1000 individuals, with an observed minimum of 252 and a maximum of 2,365. Using a bioenergetic model we estimated that a single typical *M. perspicillata* requires 706 – 851 kJ per day, equivalent to 811 – 977 g of mussel wet weight. This requirement was extrapolated to the estimated winter population, resulting in a mussel consumption of 125,128 kg during the winter season, which corresponds to 38% of the production in socks. The rest is obtained from artificial collectors. About 19% of the expected annual harvest is consumed by *M. perspicillata*. It is proposed that the predation of mussels by *M. perspicillata* in Rincon de Ballenas in the Bahía de Todos Santos is an important cause of the decline in the annual mussel production. Field observations and the bioenergetic model showed behavioural aspects that can help to implement management strategies to reduce the *M. perspicillata* impact on the mussel crop.

## USE OF CIRCUIT THEORY AND LEAST-COST SURFACE ANALYSES TO PREDICT AND PREVENT FERAL CAT PREDATION OF ENDANGERED SEABIRDS

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Federally endangered Hawai'ian Petrels (*Pterodroma sandwichensis*) and federally threatened Newell's Shearwaters (*Puffinus newelli*) nest in the remote sea cliffs of Kaua'i's north shore, specifically within the Hono o Na Pali Natural Area Reserve (HONP NAR). These long-lived species reproducing in the HONP NAR face threats from a variety of island-wide sources including power line strikes, light attraction, and invasive mammalian predators. Control of predators in HONP NAR, specifically feral cats (*Felis domesticus*), and rats (*Rattus rattus*, *R. norvegicus*, *R. exulans*), is a key element to seabird protection and management, however such management tends to be reactive to predation events. Feral cats pose a specifically devastating threat, as they tend to prey on both chicks and adults. Understanding how feral cats move through the reserve can allow management to operate in a more proactive manner to better protect endangered seabird species. Least-cost path analyses (LCP) and circuit theory have recently gained use in ecological research to predict connectivity and movement between wildlife populations. Using Arc GIS (ESRI) we created cost surfaces informed by expert opinion, habitat maps, seabird colony kernels, LiDAR data, and feral cat movement data. Using the Circuitscape connectivity analyses package, cost surface maps were combined into a single networked cost surface raster, which was run iteratively with LCP analyses to create a predictive map. The result highlights areas of high-vulnerability in the HONP NAR where trapping efforts should be focused. Such results should allow HONP NAR predator control to proactively alter current trapping efforts and strategies in a more informed manner.

## SEABIRD SOCIAL ATTRACTION PROJECTS AT CHANNEL ISLANDS NATIONAL PARK: LESSONS LEARNED 2008-2017

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During 2008-2017, we implemented two social attraction projects to restore seabird colonies at Santa Cruz and Santa Barbara islands, in Channel Islands National Park, USA. Target species were successfully attracted but unforeseen impacts by avian predators occurred. From 2008-2010, we deployed 30 artificial nests and initiated broadcast vocalization for ashly storm-petrels (*Oceanodroma homochroa*) at Orizaba Rock, offshore Santa Cruz Island. Common ravens (*Corvus corax*) began to dismantle artificial nests in 2010 and depredated at least one adult. This led to multiple iterations of artificial nest design until ceramic modules were installed in 2014 that appear to be raven-proof. We achieved the project goal to return the colony to 1996 levels of 27 nests or more, and demonstrated the effectiveness of social attraction for this species for the first time. At Santa Barbara Island, we installed 40 artificial burrows near Landing Cove in 2009 and commenced broadcasting for Cassin's auklets (*Ptychoramphus aleuticus*). In 2010, barn owls (*Tyto alba*) were observed preying upon auklets at Landing Cove; we recovered ten carcasses near the speakers. We redesigned the artificial burrows and moved the speakers closer to the coastline in an effort to reduce predation. Despite auklets nesting in Landing Cove in 2011, we discontinued utilizing amplified calls due to on-going owl predation and this sub-colony was never reestablished. This effort represented the first use of social attraction for Cassin's auklets and showed its potential as a restoration tool for this species at historic colonies. We suggest a need for adaptive management to address unforeseen issues (e.g., avian predators) when implementing social attraction projects.

## MURRE MURMURS: DOES SOCIAL INFORMATION DRIVE SUBCOLONY PARTITIONING IN THICK-BILLED MURRES?

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Agonistic interactions typically lead to non-overlapping territories for social animals. Seabirds are enigmatic because each colony often has its own distinct and non-overlapping territory, yet those territories are not actively defended. Even more mysterious, subcolonies within a colony often have their own non-overlapping territories. Explanations for subcolony partitioning include (1) environmental conditions, such as wind patterns, so that some areas are more efficiently exploited by birds nesting in particular subcolonies; (2) intraspecific competition; (3) memory, so that individuals return to the same patches; (4) social information, including information centre effects and local enhancement; and (5) a density-dependent Hinterland model where individuals avoided one another so as to exploit the nearest region with a low rate of exploitation. We tested these hypotheses using data from thick-billed murres nesting at subcolonies within Coats Island (small colony; 30 000 pairs) and Digges Islands (large colony; 400 000 pairs). For each prediction 1 to 5, we predicted that subcolony partitioning would be most pronounced (1) under particular environmental conditions that limit access to prey; (2) at large colonies; (3) for birds feeding on prey patches persistent over long time scales and among individuals; (4) for birds feeding on prey patches persistent over short time scales; and (5) where densities were highest. We found that subcolony partitioning was independent of environmental conditions, was stronger at small colonies (where density was lower), in poor years (when density was lower) and during chick-rearing, when spatial scales were small and temporal scales were short. We concluded that social information exchange, especially local enhancement, may drive subcolony partitioning.

## TERNS RETURN TO SAN ROQUE ISLAND, MEXICO AFTER 90 YEARS OF EXTIRPATION THANKS TO SOCIAL ATTRACTION TECHNIQUES AND PERSEVERANCE

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During the last century, invasive mammals extirpated at least 28 seabird colonies on the Baja California Pacific Islands, Mexico. On San Roque Island, cats (*Felis catus*) and black rats (*Rattus rattus*) were introduced in the 1940's, causing the extirpation of five seabird species: Elegant Tern (*Thalasseus elegans*, ELTE), Royal Tern (*Thalasseus maximus*, ROYT), Cassin's Auklet (*Ptychoramphus aleuticus*, CAAU), Brown Pelican (*Pelecanus occidentalis*, BRPE), and Double-crested Cormorant (*Phalacrocorax auritus*, DCCO). These invasive mammals were successfully eradicated in 1994-1995. For the first time in Latin America, in 2008 we initiated a seabird restoration program on this island with social attraction techniques (i.e., decoys, sound systems, and mirrors) for ELTE and Heermmann's Gull (*Larus heermanni*, HEEG). During this same year, we recorded the natural recolonization of CAAU, BRPE and DCCO. By 2012, we also started social attraction techniques for CAAU. Social attraction systems have been effective since the first year for HEEG and CAAU, and after nine years of perseverance for ELTE and ROYT. During the 2017 breeding season, we recorded 870 breeding pairs and more than 850 nestlings of ROYT, and one pair and one chick of ELTE, both after 90 years of their last record. Collaboration with government agencies, both from Mexico and USA, fishing cooperatives and local communities has been key for the success of this project. Comprehensive long-term projects such as this one, which included habitat restoration, active seabird restoration, monitoring, and adaptive management, are crucial to restore islands and seabird populations.

## COLLECTIVE ACTION FOR THE IMPLEMENTATION OF WATER CURTAINS AS A MITIGATION MEASURE ON THE SMALL PELAGIC FLEET IN THE GULF OF CALIFORNIA

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The small pelagic fishery is a socio-economic activity of high importance in Mexico, it is developed in Northwest Mexico, including the Gulf of California. Fishery takes the first place in volume (727,816 t.), contributing up to 40% of the total annual catches and the fifth in economic value (\$ 627,153 million pesos). In July 2011, after a process that began in October 2006, the Marine Stewardship Council certified as sustainable and well managed the fleet of 36 vessels of the small pelagic fishery in Sonora. The certification conditioned the fishery to improve its fishing practices in each of the three principles under which it operates, which entails ensuring that the Monterrey sardine population is at an adequate biomass level, that it does not affect the ecosystem drastically and has an effective management system that can react to any change in order to maintain a sustainable and responsible use of the resources. A large information gap was found in the bycatch, so in 2012 and 2013 an observer program was carried to identify the different interactions (positive or negative) that the fleet had with several species of mammals, invertebrates, fishes and birds. Being this last group the one that presents a greater interaction (negative) with the activity. In order to reduce the incidental capture of seabirds in the fishery, COBI in collaboration with CANAINPES, experts in mitigation measures, academics and producers conducted three workshops to identify strategies that will help reduce bird bycatch. As a result of the workshops, water curtains were identified as an option to be implemented during the 2017-2018 season in the sardine fishery in the Gulf of California.



## WINTERING IN THE WESTERN SUBARCTIC GYRE INCREASES EXPOSURE OF RED-LEGGED KITTIWAKES TO MERCURY CONTAMINATION

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Habitat and prey availability drive distribution of seabirds, exposing them to varying levels of environmental contaminants. Mercury (Hg) is one of the most toxic environmental contaminants and, as a neurotoxin, exposure can lead to altered behavior, reproductive failure, and decreased survival. Methylmercury is the bioavailable and most toxic Hg species and is found in high concentrations in the mesopelagic zone of the ocean. However, surface foraging seabirds, may have higher methylmercury exposure if they target mesopelagic prey that make diel vertical migrations to surface waters. We combined red-legged kittiwake (*Rissa brevirostris*) tracking data with remotely sensed oceanographic data to understand kittiwakes' foraging ecology and Hg exposure during the winter. We measured total Hg in nuptial plumage grown during late winter from red-legged kittiwakes carrying geolocation light loggers during five winters (2011 & 2013-2017; n=77). Hg is acquired through diet and Hg in feathers is related to blood Hg levels at the time of feather growth. Kittiwakes' mean Hg concentrations were  $4.63 \pm 0.97$  ppm (dry weight), and there were no differences in Hg concentrations among years. Likewise, wintering ranges were similar among years. During winter, kittiwakes were distributed within the southwestern Bering Sea and the Western Subarctic Gyre. Hg concentrations increased with the more time spent in the Western Subarctic Gyre and similarly, increased the further south (median latitude) birds were located in January and February. Our results suggest that seabirds can be used effectively to monitor contaminants over large oceanic regions that are difficult or expensive to sample using traditional ship-based methods.

AT-SEA DISTRIBUTION PATTERNS AND POPULATION SIZE OF THE ASHY STORM-PETREL  
*OCEANODROMA HOMOCHROA*

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Given the varying degree of agreement between various at-sea counts and colony counts of Ashy Storm-Petrels, it appears that a summary and analysis of the existing at-sea data would be fruitful. While existing colony-based data have been recently summarized (previous PSG Symposium), this is not the case for at-sea data. Overall, data from at-sea surveys might well provide the best insights into the actual size of the total population of this burrow-nesting, nocturnal (at colonies) species. Such natural history characteristics make colony based abundance estimates a challenge. An analysis of population estimation using at-sea data has been successfully ground-truthed for three surface-nesting seabird species, two from the Farallon Islands and one from the Galapagos; another at-sea population estimate was verified by radar studies of burrow-nesting seabirds in Hawaii. The key is to have intensive surveys covering an appreciable portion of the at-sea range of the species in question. In this regard, likely there is no other seabird in the world that like the Ashy Storm-Petrel has had most of its entire at-sea range intensely, and repeatedly surveyed, 1976-2015. Herein we summarize and analyze existing at-sea data to derive an estimate of the world population of this species, and to detect “hotspots” where it concentrates.

## ANTHROPOGENIC LIGHT AT NIGHT DISTRACTS AND DISORIENTS SEABIRDS - A NEW STRATEGY TO LOCATE AND RECOVER FALLOUT BIRDS

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Worldwide, seabirds become disoriented by artificial lighting altering their flight paths, causing them to crash into human structures or land due to exhaustion. Once grounded, they are susceptible to introduced mammalian predators, and vulnerable to vehicle traffic. On Maui, the federally endangered, endemic Hawaiian petrel (*Pterodroma sandwichensis*) and Wedge-tailed shearwater (*Ardenna pacifica*) are negatively impacted by light distraction during the fall fledging season. To reduce seabird mortality, we encourage the public to call our Save Our Seabirds (SOS) Downed Seabird Hotline to immediately report grounded seabirds. MNSRP staff respond to SOS calls by locating the bird, documenting the scene (lights & wires presence), and evaluating the bird for release. While the SOS hotline has mitigated mortality from light-induced groundings, it relies on public participation, and requires outreach and education. In fall 2017, to supplement the SOS hotline, we used VIIRS satellite light radiance data with historic fallout records (n=627) to identify a quadrant near a seabird colony with high radiance but low fallout reports. We hypothesize that light radiance mapping can predict areas with high fallout and increase the number of recovered seabirds. We actively searched twice a week after sunset in anticipation of unreported grounded birds, driving a set circuit (13 km) and searching on foot (41,757 m<sup>2</sup>) within the perimeter of large commercial areas (survey time = 1 hr). Because seabird fallout occurs primarily during fledging, and the number of downed birds varies annually due to many factors, several years of directed searching guided by radiance data will support the usefulness of the method.

## THE GENETICS LEGACY OF HARRY CARTER

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In addition to his contributions to seabird ecology and conservation, Harry Carter made at least three key contributions to seabird genetics and systematics. Beginning in the late 1990s, Harry contributed to discussions and sample collections for a population genetic study of marbled murrelets (*Brachyramphus marmoratus*) to aid identification of distinct population segments for conservation. This study revealed that murrelet populations in central California and the Aleutian Islands are genetically different both from each other and from murrelets in the rest of the range. Subsequently, along with David Ainley, Harry encouraged our lab to investigate genetic relationships among Leach's storm-petrels (formerly *Oceanodroma leucorhoa*) in southern California and Baja Mexico, and helped to coordinate sample collections. This study revealed that storm-petrels breeding in Guadalupe are genetically isolated from those elsewhere, supporting their elevation to full species. Harry also drew our attention to the fact that storm-petrels breeding off southern California vary clinally in morphology, leading to a fine-scale population genetic study of storm-petrels in the area. Perhaps most importantly, Harry initiated a population genetic study of Xantus's murrelets (formerly *Synthliboramphus hypoleucus*), including coordinating collection of samples from every breeding colony, securing funding, and participating actively in data interpretation and write-up. Results revealed that murrelets breeding in Guadalupe are genetically isolated from those breeding elsewhere, leading the American Ornithologists' Union to recognize two species: Guadalupe (*S. hypoleucus*) and Scripps's (*S. scrippsi*) murrelets.

## PREDATOR ACTIVITY AND HAWAIIAN PETREL RECRUITMENT ON LEEWARD HALEAKALĀ

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Maui Nui Seabird Recovery Project works to protect endangered seabirds and their habitat by carrying out a suite of field research and restoration projects on the leeward slope of Haleakalā, at elevations above 6,800 ft. Our field work includes long-term monitoring of the vegetative communities, automated acoustic monitoring for seabirds, predator surveys and control, and close monitoring of Hawaiian petrel breeding activity ('Ua'u; *Pterodroma sandwichensis*). As of late 2017, several components of these activities yielded positive trends for the recent increase of 'Ua'u recruitment on Leeward Haleakalā. The trends may be attributable to ongoing ecological restoration efforts.

We have monitored 'Ua'u burrows and predator activity in the Kahikinui Forest Reserve and Nakula Natural Area Reserve since 2012. Results from standardized ground surveys show an expansion of established 'Ua'u burrows within our study area. Burrow monitoring camera data also reveal increased 'Ua'u breeding activity. Predator tracking data confirm expected, low populations of nest predators. Nevertheless, we recorded 'Ua'u nest predation by feral cats. Predator control efforts are carried out both systematically and opportunistically, and have helped reduce predator numbers and suppress 'Ua'u depredation. Leeward Haleakalā offers a promising area of increased recruitment for 'Ua'u. The mostly intact native vegetation community, relatively low predator population, and positive trends in 'Ua'u breeding activity justify continued restoration efforts and monitoring. More data will clarify the role of these factors in 'Ua'u recruitment into our study area.

## A COMPARISON OF HERRING GULL (*LARUS ARGENTATUS*) FORAGING BEHAVIOR ALONG AN URBAN GRADIENT

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Urbanization can impact seabird populations and communities through a variety of different mechanisms. As generalist foragers, herring gulls (*Larus argentatus*) have thrived in urban areas by adapting to forage on human-derived food, but it is unclear how dependence on these food sources influences their foraging behavior and microbiome. We deployed GPS tags (n=45) and took cloacal swabs (n=35 to compare the foraging behavior and microbiome of gulls at each of 3 colonies in the Northeast U.S. that differ in their proximity to a major metropolitan center (Jamaica Bay in New York City, an intermediate colony at Young Island in Stony Brook, New York, and a more remote colony at Tuckernuck Island in Massachusetts). We used First Passage Time analysis to identify foraging locations, and used linear mixed effects models to compare colony-level differences in trip metrics and the proportion of foraging areas occurring within human habitats. Gulls at Jamaica Bay and Youngs Island foraged in human habitats significantly more often than those at Tuckernuck. Gulls from Young's island exhibited significantly longer trips in terms of both total distance and duration than those at Jamaica Bay and Tuckernuck Island, and site fidelity was significantly higher for birds at Jamaica Bay than for gulls at Tuckernuck or Young's island. Our results to date suggest that the use of urban environments as foraging habitat greatly influences the foraging behavior of herring gulls at the colony level. Analyses of the gull microbiome using next generation sequencing techniques are ongoing and preliminary results providing comparisons between gulls foraging on human-derived and natural sources will be discussed.

BREEDING POPULATION TRENDS OF THE DOUBLE-CRESTED CORMORANT ON ISLA ALCATRAZ,  
GULF OF CALIFORNIA, MEXICO

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The Double-crested Cormorant (*Phalacrocorax auritus albociliatus*) has been the subject of study and management on the Pacific coast of North America for decades. In spite of the high profile maintained by Double-crested Cormorants in the United States and Canada, little is known about current colony estimates and population trends in Mexico. In the early 1970's, surveys on Double-crested Cormorants were conducted on Isla Alcatraz in the Gulf of California. The results of these surveys estimated approximately 1,500 breeding pairs, making it the largest colony in the Gulf. In 2000, Prescott College initiated long-term monitoring of cormorants on Isla Alcatraz to investigate recent colony size and trends. Active nests counts were collected during the breeding season (October through January) between 2000/01-2016/17. During initial survey years from 2000/01-2012/13 the average peak nest count was 1,472 nests. The highest recorded nest count was 1,968 nests in 2010/11. Low nest counts of 605 and 857 nests were recorded in 2013/14 and 2014/15, respectively, but have since increased. The years of reduced nesting may reflect impacts of El Niño events documented in breeding seabirds. The colony on Isla Alcatraz remains the largest known nesting colony of Double-crested Cormorants in the Gulf of California and continual monitoring is important due to its relative stability and unique nesting phenology.

## CONTAMINANTS, FORAGING ECOLOGY, AND BREEDING HORMONES IN TWO SYMPATRICALLY BREEDING SOUTHERN OCEAN SEABIRDS

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In seabirds, contaminants originate from diet, and thus knowledge of foraging ecology is closely linked to knowledge of contaminant loads, physiology, and breeding. This is especially important because contaminants like mercury can act as endocrine disruptors, and endocrine-disrupting compounds adversely affect many aspects of physiology and reproduction. We measured mercury, the breeding hormone prolactin, and carbon and nitrogen stable isotopes during the incubation period in two species, Flesh-footed Shearwaters (*Ardenna carneipes*) and Great-winged Petrels, (*Pterodroma macroptera*) that breed in south Western Australia. Our objectives were to: 1) establish baseline levels of blood-based contaminants and hormones, and describe foraging ecology of incubating parents from these little-studied populations; and 2) assess the relationships between contaminants, hormones, and foraging ecology. Great-winged Petrels exhibited sex-based differences in prolactin, but there was no relationship between mercury and prolactin in either species. Great-winged Petrels foraged offshore and had significantly higher mercury concentrations ( $3.430 \pm 0.698 \mu\text{g g}^{-1} \text{ ww}$ ,  $n=15$ ) than the coastally-foraging shearwaters ( $0.644 \pm 0.378 \mu\text{g g}^{-1} \text{ ww}$ ,  $n=12$ ,  $p<0.001$ ), suggesting that mercury exposure is due to differences in diet and foraging areas between species. In addition to establishing a baseline, these data are especially important because Flesh-footed Shearwater populations are declining globally, and the Great-winged Petrel is understudied and population trends are unknown.



## FIRST OBSERVATIONS OF MAGNIFICENT FRIGATEBIRD CHICK-REARING MOVEMENTS IN MEXICO

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Frigatebirds are easily recognizable species observed in coastal regions throughout the tropics. However, little is known about their foraging movements, especially during the breeding season. We combined GPS-tracking data with remotely-sensed oceanographic variables to elucidate foraging areas and environmental characteristics of foraging habitats of Magnificent Frigatebirds, (*Fregata magnificens*) at three colonies in Mexico: two colonies in the Gulf of California (Isla Pajaros, Sinaloa, n=21 trips; and Isla Isabel, Nayarit, n=6 trips) and one colony in the Gulf of Mexico (Arrecife Alacranes, Yucatan, n=8 trips). Inter-colonial differences in foraging behaviors were distinct: birds in the Gulf of California traveled the furthest (up to 150 km from the colony), and birds in the Gulf of Mexico stayed close to the colony (within 30 km) and additionally roosted on a nearby islet. Frigatebirds in the Gulf of California used alongshore upwelling regions extensively, with most birds from Isla Isabel traveling >100 km northeast to the shallow mainland coast instead of using deeper waters at the edge of the continental shelf, only 80 km to the west. Similarly, frigatebirds at Isla Pajaros remained within 50 km of the shallow (100 m depth) coast, but traveled up to 100 km up and down the coast, where chlorophyll-a averaged  $2.1 \pm 1.3 \text{ mg m}^{-3}$ , the highest chlorophyll observed among all colonies. Conversely, frigatebirds at Arrecife Alacranes foraged in shallow (<70 m) waters with little topography-driven upwelling and moderate productivity ( $1.1 \pm 1.2 \text{ mg m}^{-3}$ ). Overall, it is likely that regional differences in both oceanography and potential food availability contribute to the foraging movements of these iconic tropical species.

## WHAT RISKS DO OFFSHORE LIGHTS AND FLARES POSE TO LEACH'S STORM-PETRELS IN ATLANTIC CANADA?

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Recent surveys of Leach's Storm-Petrel (*Oceanodroma leucorhoa*) colonies in Atlantic Canada have revealed up to 50% declines over the past 30 years, including at Baccalieu Island, Newfoundland and Labrador (NL) where the world's largest population breeds. As a result of these declines, BirdLife International recently uplisted the species to Vulnerable on the IUCN Red-List. Previous work suggests several causes for the population declines, including predation at the colonies, contaminants, climate-driven changes in the food supply, and mortality risks at sea, including at offshore oil and gas platforms where birds are attracted to artificial lights and flares. Leach's storm-petrels are the most common species found stranded on offshore platforms in Atlantic Canada (90% of all reported strandings), 17% of which are found dead or die before release. We used GPS tags in 2016 and 2017 to track adult breeding birds from four colonies in NL and Nova Scotia (NS), three of which are declining, to quantify their extent of spatial overlap with offshore oil and gas platforms during the incubation period. Data from tags we retrieved (69/82) indicated that 47% of the birds from Gull Island, NL, 50% from Country Island, NS, and 20% from Bon Portage, NS passed through the production areas on their way to or from offshore feeding areas. Interestingly, no tracks from Baccalieu Island overlapped with the offshore oil and gas area during this time. Modelling the cumulative impacts of various stressors across colonies is needed to better understand the demographic drivers of the population declines, and inform the mitigation of threats, including those posed by offshore oil and gas infrastructure.

## COMMON MURRE RESTORATION PROJECT AT DEVIL'S SLIDE ROCK: HARRY CARTER'S VISION COMES TO FRUITION

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Common murre (*Uria aalge*) stopped breeding at Devil's Slide Rock, San Mateo County, California following the 1986 Apex Houston oil spill. Natural recolonization did not occur between 1987 and 1995. In 1996, we began using social attraction (e.g., decoys, amplified vocalizations and mirrors) to stimulate nesting at this extirpated colony. Murre began attending the colony regularly within 24 hours of creating the simulated colony and six pairs nested by June 1996. The original 10-year goal of 100 breeding pairs was obtained after only five years. As the colony grew, decoys arrangements were modified to encourage development of dense core breeding groups. The number of breeding pairs of murre increased to 190 breeding pairs in 2005; the last year social attraction equipment was used. By 2013, colony size and distribution were similar to levels observed prior to the oil spill. We summarize factors influencing murre attendance and nest site selection during the initial years of social attraction, present new information on spatial effects on murre reproductive performance at this re-established colony, and highlight additional seabird conservation actions that have occurred because of this project.

## DATE OF BREEDING AS A PROXIMATE FACTOR TO CHANGES IN THE FORAGING EFFORT OF GUANAY CORMORANTS IN PERU

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The guanay cormorant (*Phalacrocorax bougainvillii*) is endemic to the Humboldt current along the coast of Perú and Chile. They breed asynchronously within an extended period and therefore it is common to find chicks of the same age on different months of the year. This scenario allows the possibility to test the effects of breeding dates (and food availability) on the foraging effort of chick rearing-adults. We test this hypothesis in guanay cormorants tracked with GPS-TDR loggers at Punta San Juan, Perú, where ~ 100 000 breeding pairs nested between Dec 2016 and Mar 2017. The total distance traveled was greater, the trip duration longer and the number of dives/bout higher in February (60.33 km, 4.86 h y 20.72, respectively) than in January (40.3 km, 2.47 h y 17.08) indicating a higher foraging effort of cormorants as the season progressed. The changes on foraging effort also matched changes in diet composition as prey diversity was higher in February than in January (11 spp. vs 5 spp. of fish). When foraging effort was lower in January, cormorants fed predominantly on Peruvian anchovies (*Engraulis ringens*). Likewise, the differences in foraging behavior was likely to be accentuated by the occurrence of a coastal El Niño in 2017.

## NATURAL TAIL STREAMER ASYMMETRY AND APPARENT SURVIVAL OF MAGNIFICENT FRIGATEBIRDS (*FREGATA MAGNIFICENS*)

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Flight traits that are mediated by symmetry could be constrained by either mechanical or aerodynamic effects. Natural asymmetry of external tail feather could have unfavourable effects on aerodynamic performance of birds, increasing energetic costs, or negatively affecting survival of highly aerial birds. The Magnificent Frigatebird, *Fregata magnificens*, is a highly aerial seabird with a deeply forked tail, and an extraordinary division of labour between sexes. Its flight pattern is mainly soaring and dynamic soaring flight using sea local wind patterns; it also has fast active flight and performs acrobatic manoeuvres. We addressed whether tail streamer asymmetry and survival are correlated apparent survival in the Magnificent Frigatebirds. We considered tail streamer asymmetry and tail length during the breeding season, and used mark-resighting analysis from six years of live-encounter data (2000-2005). Magnificent frigatebirds showed a significant difference between left and right tail length, as well as tail asymmetry differences between sexes. Our models did not find a clear effect as individual covariates of tail streamer asymmetry and tail length by sex in annual apparent survival. Natural variation in a secondary sexual trait such as the tail streamer, of this long lived and highly aerial seabird likely does not affect survival. Life-history strategies such as flight mode, breeding behaviour, and tail molt may constrain negative survival effect. Nevertheless, longer mark-resighting studies and additional modelling are needed in order to answer conclusively the question of survival and flight traits in Magnificent Frigatebirds.

INTER-ANNUAL AND INTER-SEXUAL VARIATION IN THE FORAGING AREAS OF BROWN BOOBIES  
AT PEÑA BLANCA ISLAND, COLIMA, MÉXICO

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Despite being a widespread seabird throughout tropical regions of the world, there are still uncertainties in the knowledge of the ways Brown Boobies cope with changing oceanographic conditions, both geographic and temporal. We aimed at increasing such knowledge by studying the number and duration of foraging trips and the feeding areas of Brown Boobies (*Sula leucogaster*) breeding at Peña Blanca Island, between 2015 and 2017. We obtained data from 317 foraging trips of 50 individuals with GPS devices (weight = 20g, data recording every minute). Brown Boobies consistently used an area restricted to < 40 km from the colony, using intensively the coastal zone. However, occasional trips between 40 km and 90 km from the colony were not rare. There was inter-annual and intra-annual variability in the distance traveled and the areas used for foraging. In all years, females travelled farther than males, and foraged in more distant places. Distance traveled from the colony was greatest in 2017 (54.4 km ± 26.6), and smallest in 2016 (33.5 km ± 7.7). There was a remarkable plasticity in the duration, distance and direction of foraging trips, and such plasticity was likely related to changes in food availability at local scale. Despite this, a narrow, < 10 km wide, strip along the coast was an important foraging area throughout the three years of study. The data we generated reflects the foraging flexibility that allows the Brown Booby to be a widespread seabird that occupies areas under different oceanographic conditions, adjusting to inter-year changes in resource availability.

## SOME ASSEMBLY REQUIRED: MONITORING SEABIRD INDICATORS FOR THE CALIFORNIA CURRENT INTEGRATED ECOSYSTEM ASSESSMENT

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The California Current Integrated Ecosystem Assessment (CCIEA) is an ongoing effort to understand relationships between and among environmental drivers and pressures and key ecosystem components and to promote ecosystem-based management by forecasting how changing environmental conditions and management actions will affect the California Current Large Marine Ecosystem. The CCIEA informs a wide variety of stakeholders and agencies that rely on science support for ecosystem-based management by integrating information collected by a variety of federal and state agencies, non-governmental organizations, and academic institutions. One aspect of this information gathering is monitoring the status and trends of key indicators, including drivers and pressures (climate and ocean drivers, social drivers), human activities, focal ecosystem components (coastal pelagic species, groundfish, highly migratory species, marine mammals, salmon, seabirds, human well-being), and mediating components (habitat, local social systems). The initial goal for the seabird ecosystem component is to assemble and present an annual synoptic view of seabirds by monitoring the status and trends of seabird indicators throughout the California Current. Through extensive collaboration, we are monitoring key seabird indicators (at-sea densities, breeding performance, diet, and mortality) to reflect their role as both an important ecosystem component and as a barometer of the ocean environment. While we are assembling and sharing some time series for seabird indicators, we continue to seek collaboration and partnerships along the continental U.S. West Coast in order to make available an up-to-date, synthetic view of seabirds throughout the California Current.

ECOLOGICAL DEMOGRAPHY OF A *STERNULA LORATA* POPULATION ON THE SOUTHERN BOUNDARY OF ITS DISTRIBUTION: CONSERVATION PERSPECTIVES BASED ON THREATS/ACTIONS ANALYSIS

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According to Chilean law, Least Tern or Gaviotín Chico (*Sternula lorata*) has been classified as an Endangered Species (DS 151/2007 MINSEGPRES). The distribution of this species has its southern boundary at Mejillones Peninsula (23° S) at the coasts of the Atacama Desert where the main factors that regulate biodiversity distribution and abundance are sub-Antarctic cold waters of the Humboldt current, coastal upwelling systems, and El Niño events. In this scenery we studied seven Least Tern nesting sites from 2008 to 2016 reproductive seasons. Each site was characterized according to its characteristics, nest/egg production by season and environmental conditions. There were 1926 accumulated active nests, and the main sites were Mejillones Pampa (58%) and Hornitos-GualaGuala (25%). We recorded 1302 (68%) two-egg clutch size nests and 621 (32%) one-egg clutch size nests. A total of 3234 eggs were produced, 68% of which hatched successfully while 32% failed. Mean population size of this distributional segment varied from 136 individuals in 2008 to a maximum of 870 in 2016. We estimated egg and hatchling predation by feral dogs as 42.4%, Southern Caracara as 31.3%, Variable Hawk (*Buteo polyosoma*) as 15.6%, Turkey Vulture as 10.1%, and Culpeo Fox as 0.5%. Recorded flying terns (adult and fledgling) predators were Peregrine and Aplomado Falcons (*Falco peregrinus* and *Falco femoralis*). We evaluated with local community members (stakeholders) the main threats that affect Gaviotín Chico reproduction and population survivorship, and agreed with an ordered list of negative factors with human responsibility and actions needed to counteract the deterioration trend of recent decades.



## IMPACTS OF PREY AVAILABILITY ON THE FORAGING BEHAVIOR AND DIET OF TWO ALCIDS IN NORTHEASTERN NEWFOUNDLAND

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Foraging seabirds are largely constrained by prey abundance, distribution, and predictability and, thus, these species require a degree of plasticity in both behavior and diet. On the northeastern Newfoundland coast, inshore migration of spawning capelin (*Mallotus villosus*) provides an important influx of abundant prey partway through the breeding season, transforming prey availability from low (pre-spawning) to high (spawning). This study aimed to examine the impacts of varying capelin availability on the foraging behavior and diet of common murre (*Uria aalge*) and razorbills (*Alca torda*). Foraging behavior was quantified using GPS loggers (Ecotone UR1A) deployed for 15 days during which capelin availability changed from low to high. Diet was estimated during both periods using stable isotope analysis (<sup>15</sup>N, <sup>13</sup>C) of blood plasma and red blood cells. Foraging trip parameters (e.g., range, duration, dive effort) were more variable when capelin availability was low, but trip parameters of murre did not vary as availability changed. Alternately, razorbills reduced their foraging range (low: 15.1±3.0km, high: 3.9±1.2km) and dive effort (low: 31.2±5.3 dives/h; high: 13.2±1.7 dives/h). Both species shifted core foraging areas closer to breeding colonies and capelin spawning sites during high capelin availability, suggesting the importance of spawning sites to chick-rearing alcids. This spatial shift was mirrored in a dietary niche shift to a more capelin-based diet, but to varying degrees. Findings suggest that razorbills may exhibit higher plasticity in foraging behavior, but changes in space use with increased capelin availability suggests that both species take advantage of the influx of nearby highly abundant prey.

## RESULTS OF SEABIRD SURVEY AT SERIBUAT ARCHIPELAGO, JOHOR, MALAYSIA

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Thirty-one seabird species can be found in Malaysia (breeding & migrant), very few species are still breeding on a number of rocky outcrops and small islands. The century-long egg taking by local fishermen believed to cause extirpation of several breeding species. To update the current status of seabirds along the east coast waters of Peninsular Malaysia, a series of field surveys were conducted during August 2017 at Seribuat Archipelago, Johor, Malaysia. Twelve islands/outcrops (out of 64 islands) were selected and surveyed using boat observation/ colony landing survey. In total over 6200 birds were counted in two-day survey, representing five tern species: Bridled Tern (*Onychoprion anaethetus*), Black-naped Tern (*Sterna sumatrana*), Great Crested Tern (*Thalasseus bergii*), Roseate Tern (*Sterna dougallii*) and the Lesser Crested Tern (*Thalasseus bengalensis*). The first two species are confirmed breeding, while other species are either passage migrants, or breeding needs confirmation earlier in the season. The survey led to rediscovery of small population of roseate tern at Pulau Yu (one of two site of the species breed in Malaysia). None of the islands surveyed are legally protected, protection of selected sites is highly recommended to conserve these remaining seabird populations. This survey was funded by Department of Marine Parks Malaysia.

## EVIDENCE FOR BI-DIRECTIONAL MIGRATION AND HISTORIC POPULATION GROWTH FROM DEMOGRAPHIC RECONSTRUCTION OF PACIFIC AND ATLANTIC LEACH'S STORM-PETREL POPULATIONS

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The Atlantic Leach's Storm-Petrel (*Oceanodroma leucorhoa*) population is thought to have split from the founding Pacific population roughly 15-20,000 years ago. Previous studies based on microsatellite and mitochondrial loci have suggested that migration between the two populations is primarily one-directional (Pacific to Atlantic) and that the Pacific population has recently expanded. Here we present a new coalescent demographic reconstruction based on 100 genomic loci generated from high resolution RAD sequencing. We present strong evidence to indicate that migration between the Pacific and Atlantic populations is bi-directional and substantial, although minimal in comparison to estimated total population sizes, and that both populations have likely experienced population growth in recent pre-industrial history. Despite the apparent gene flow between the two populations, we also found different alleles in immune regions (Major Histocompatibility Complex MHC Class IIb) present in the two locations, indicating divergent functional evolutionary histories. In addition, we found some genomic loci that are strongly differentiated between the two populations, which may indicate local adaptation. Given that historic migration patterns between the Pacific and Atlantic may be altered by future climate conditions, it is critical that we understand any differential immune and environmental adaptations in each population.

## COMMUNITY EDUCATION IN THE CONSERVATION OF *STERNULA LORATA* IN CHILE

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Fundación para la Sustentabilidad del Gaviotín Chico (*Sternula lorata*) was formed in 2008 and the first public-private collaborations in Chile whose objective is the protection of an endangered bird. The Foundation has generated valuable information so that the public may learn about, value, and adopt this species as part of the community of Mejillones. The objective is to achieve industrial development compatible with the care and protection of this species through different activities that have been developed collaboratively with the community, local industry, and local management authorities. The foundation has worked with more than 60% of the social organizations within Mejillones and formed agreements, work tables and strategic alliances enabling the protection of the tern. We trained 1,000 workers at the companies in 2016. We have provided outreach to nearly 8,000 people who in some way or another have received information about the conservation problems of the species.

## INTERACTION OF FISHING OPERATIONS WITH SEABIRDS IN SMALL PELAGIC FISHERIES

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The analysis of the interaction of seabirds with the smaller fish fishery was carried out in three regions of the Pacific Ocean: Gulf of California, Boca del Golfe, and the California Occidental Coast of Baja California Sur. The mortality rate of seabirds caused in fishing operations was calculated. The data collected by the Observer Program during 2017 recorded 122,301 seabird sightings, of which 85.2% were adult birds and 14.8% are juvenile birds. The greatest abundance is in April and May, outstanding the brown pelican (*Pelecanus occidentalis*) as the most frequent and abundant species, which potentially presents a higher probability of interaction in the fishery. After the pelican were the Heermann's gull (*Larus heermanni*) and the Laughing gull (*Leucophaeus atricilla*) with the highest sighting frequency. The sighting total of birds with respect to the purse-seine net, 88.7% of the birds sighted in the environs of the ship and 11.3% directly in the operation of the red zone. The total mortality in the fishery was 0.003 and an estimated survival of 0.997. Regarding the number of fishing spears, the general rate for the fishery was 0.26 individuals per fishing spear. These results mean that there are no incidental deaths of seabirds. Mortality rates estimated at 545 fishing trips were very low during the study period, which represents an advance in the application of mitigation measures undertaken by the fishing fleet.

RECOLONIZATION OF GUADALUPE ISLAND BY THE GUADALUPE MURRELET  
(*SYNTHLIBORAMPHUS HYPOLEUCUS*) AND UPDATE ON ITS POPULATION STATUS

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The endangered Guadalupe Murrelet (*Synthliboramphus hypoleucus*, GUMU) concentrates 97% of its breeding population on the Guadalupe Island Biosphere Reserve. In the 19<sup>th</sup> century, the introduced feral cat (*Felis catus*) caused the extirpation of this species from Guadalupe Island, leaving two islets: Morro Prieto and Zapato, which are located south of the main island, as the only nesting sites. As part of our seabird restoration program on the Reserve, since 2015 we have conducted research on this species population status, productivity, and spatial distribution. In 2014, we built a feral cat exclusion fence in Punta Sur—located in the southernmost portion of Guadalupe Island—establishing a 62-hectares peninsula free from feral cats. Just a couple of years without cat predation, in 2016 we recorded the presence of two pairs of GUMU nesting within the fenced area. In 2017, we recorded 40 pairs thus confirming the recolonization of this species on Guadalupe Island after 90 years of extirpation. The current breeding population has varied from 400 to 530 pairs during the last three years, with a low productivity ranging from 15% to 33%. The recolonization by GUMU is an encouraging outcome that demonstrates the positive impact that the recently initiated four-year feral cat eradication program will have on the island's bird species.

LAYSAN ALBATROSS (*PHOEBASTRIA IMMUTABILIS*) ON GUADALUPE ISLAND, MEXICO:  
POPULATION STATUS, DISTRIBUTION, SOCIAL ATTRACTION AND ADVANCES TOWARDS THE  
ERADICATION OF FERAL CAT

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Guadalupe Island and its islets, off the Baja California peninsula in Mexico, support the most important growing Laysan Albatross (*Phoebastria immutabilis*, LAAL) breeding colony in the eastern Pacific Ocean. Feral cats, introduced to the main island more than 100 years ago, are the most serious threat to this population. To protect LAAL and other nesting seabirds, we initiated a permanent control program for feral cats (*Felis catus*) around nesting colonies in 2003. In 2014, we built a feral cat exclusion fence in the main island in Punta Sur. Two years later, once feral cats were eradicated from the 62-hectares fenced peninsula, in 2016 we started social attraction activities (i.e., decoys and sound systems) for LAAL and burrow-nesting species (e.g., Guadalupe Murrelet, *Synthliboramphus hypoleucus*). We have been doing research on: population status, reproductive success, spatial distribution, and effectiveness of social attraction systems. Currently, the LAAL total breeding population on Guadalupe Island and its islets is 2,262 individuals. This population's reproductive success is one the highest recorded for the species, with 60% to 88% of nests producing a fledgling. In 2017, 4% of the nests were associated to social attraction systems and many breeding interactions were recorded. Furthermore, we formulated a Management Plan for LAAL that identifies priority conservation actions. We started our four-year feral cat eradication project in April 2017, which represents the highest priority conservation action not only for LAAL but for other native land and marine bird species.

## CONSERVATION STATUS OF THE ASHY STORM-PETREL (*OCEANODROMA HOMOCHROA*) IN MEXICO

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The endangered Ashy Storm-Petrel (*Oceanodroma homochroa*, ASSP) is a species with a declining population and a restricted breeding distribution in the Pacific Ocean. In Mexico, the Coronado Archipelago, off the Baja California Peninsula, is recognized as its only breeding colony, while knowledge about its biology and conservation needs is very limited. As part of an ongoing binational seabird restoration and monitoring program in Mexican Pacific islands, since 2013 we have deployed social attraction systems (i.e., artificial burrows and sound systems); evaluated the current distribution range, number of breeding pairs, reproductive performance, breeding phenology, and threats for this species; and performed outreach activities to raise awareness with island users. We recorded a breeding range expansion to the south: an increasing breeding colony on Todos Santos islands since 2014, and breeding adults on San Martín Island in 2017. Moreover, we have recorded an asynchronous timing of breeding in one of the islands through, at least, nine months during the year, and a high productivity. Current conservation needs include habitat restoration and evaluating the impact of predation and light pollution around the islands. These conservation actions and the recent creation of the Baja California Pacific Islands Biosphere Reserve—which protects all its breeding colonies—together with outreach activities, are creating a new environmental consciousness on island users towards the long-term conservation of the seabird community in this region.



## A GLOBAL REVIEW OF THE MIGRATORY CONNECTIVITY OF SEABIRDS TO ADVANCE AREA-BASED PLANNING AND NETWORK APPROACHES IN AREAS BEYOND NATIONAL JURISDICTION

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Due to their large geographic ranges, migratory seabirds experience a variety of anthropogenic pressures. Combined with management strategies that largely fail to consider connectivity throughout seabirds' annual cycles, these threats have contributed to global population declines. Information on migratory connectivity is vital for marine spatial planning initiatives focused on areas beyond national jurisdiction (ABNJ), however, this information is not widely available and has not been effectively synthesized for planning purposes. To fill this gap, The Marine Geospatial Ecology Lab (MGEL) of Duke University is leading a consortium to develop the Migratory Connectivity in the Ocean (MiCO) System as part of a larger grant to the Global Ocean Biodiversity Initiative. MiCO seeks to synthesize data about the migratory connectivity of seabird species utilizing ABNJ, and from these data, to identify connected sites used. We are collating geospatial data from a systematic literature review of 86 seabird species including information derived from telemetry, mark/recapture, stable isotope, and genetic studies. Information on sites (areas used for a particular life cycle activity) and routes (migration and foraging paths) will be summarized, and regional and thematic gaps will be identified. In future phases, a total of 119 seabird species will be included in the MiCO System. Geospatial products, including nodes (aggregated sites) and corridors (aggregated routes), will be used to incorporate connectivity into area-based planning in ABNJ. Here we present initial results detailing the information available on migratory connectivity of seabirds across ABNJ.

## PLASTIC INGESTION BY TWO SPECIES OF NORTH PACIFIC FORAGE FISHES COLLECTED FROM SEABIRDS

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We tested the hypothesis that the local at-sea density of plastic determines its prevalence in marine zooplanktivores using two North Pacific forage fishes, the Pacific sand lance (*Ammodytes personatus*) and Pacific herring (*Clupea pallasii*), as study subjects. We quantified the amount of plastic found in the stomachs of 734 sand lance and 205 herring that had been captured by Rhinoceros Auklets (*Cerorhinca monocerata*), on six breeding colonies in British Columbia and Washington State over one to eight years. The North Pacific Ocean is a global hotspot for plastic pollution, yet few sand lance (1.5%) or herring (2.0%) had ingested plastic, and there was no systematic relationship between the prevalence of plastic in fish stomachs vs. in waters around three of our study colonies. Sampling at a single site (Protection Island, WA) in a single year (2016) yielded most (sand lance) or all (herring) of the plastic recovered over the entirety of this study, yet no plastic had been found there, in either species, in the previous year. We conclude that (1) the local at-sea density of plastic does not necessarily determine how much plastic enters marine food webs via zooplanktivores, and (2) at present, sand lance and herring, two key constituents of Northeastern Pacific food webs, do not act as primary food-web conduits for plastic along British Columbia's outer coast. Extensive urban development around the Salish Sea was a probable cause of the higher plastic loads in fishes collected on Protection Island, but we cannot account for the between-year variation. Nonetheless, the existence of marked interannual variation indicates the importance of measuring year-to-year variation in plastic pollution both at sea and in marine biota.

## RESPONSE OF RHINOCEROS AUKLETS TO AN ANOMALOUSLY POOR BREEDING SEASON

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The effectiveness of using seabirds as indicators of marine conditions is a function of their sensitivity to changing environmental conditions, with behaviorally plastic species typically showing little interannual variability in reproductive parameters. In 2016, we documented a highly anomalous breeding season for Rhinoceros Auklets (*Cerorhinca monocerata*) on Protection Island (PI), WA, in the Salish Sea but not on Destruction Island, on the outer Washington coast. We continued our long-term breeding season monitoring at both breeding colonies in 2017, providing us with the opportunity to evaluate the population-level response to the 2016 season. On Protection Island, burrow occupancy (the proportion of burrows that were reproductively active) was the lowest recorded in 12 years of monitoring (58% vs. long-term mean of 72%). In contrast, hatching and fledging success were both comparable to the 12-year mean values, 85% and 78%, respectively. As in 2016, none of the three reproductive parameters differed from long-term mean values for the Destruction Island breeding population in 2017. In stark contrast to 2016, nestling provisioning, as measured by fish per bill load and bill load weight, on PI was comparable to long-term values. The lower burrow occupancy on PI suggests a population-level effect from the 2016 breeding failure and a concurrent adult mortality event. This depressed breeding effort may have been driven by elevated adult mortality the previous summer and/or birds deciding not to breed during the 2017 season.

## TRACKING INVASIVE SPECIES ERADICATIONS AT A GLOBAL SCALE

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Indicators for tracking conservation efforts at a global scale are rare. Yet they are necessary for understanding trends and measuring progress towards global conservation targets. Eradication of invasive species from islands is an increasingly used conservation intervention globally. With a goal of collating these efforts, the Database of Islands and Invasive Species Eradications (DIISE) holds records of the location, target species, year and outcome of invasive mammal and bird eradication on islands from around the world. The database is available in Spanish and English, at [diise.islandconservation.org](http://diise.islandconservation.org), and represents a partnership between the University of California at Santa Cruz, University of Auckland, IUCN Invasive Species Specialist Group, LandCare Research and Island Conservation. The database contains more than 1,200 eradication attempts, with an overall success rate of 85%. The intent is to update and maintain the database, thus we expect these numbers to change as new eradication attempts are added, and knowledge about existing events improves. The DIISE relies on contributions from experts, and we encourage all attendees of the conference to review events they are familiar with, and contribute new events. Here we present database history, parameter definitions and key trends. We also highlight additional studies the underlying data has contributed to, including evaluating the native species benefit from this important conservation intervention, and global indices to track progress to the Convention of Biological Diversity Aichi target 9 (Invasive Alien Species).

## BEHAVIORAL, GENETIC AND MICROBIAL VARIATION CORRELATES WITH FEMALE BUT NOT MALE QUALITY IN BREEDING LEACH'S STORM-PETRELS (*OCEANODROMA LEUCORHOA*)

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Conventional mate choice theory predicts the choosy sex to select a mate by acting on variation in quality among the competing and unselective sex. In most organisms, females represent the choosy sex, reflecting the physiological costs females incur in egg development or pregnancy, while males perform courtship displays or compete for access to females. However, exceptions to this pattern are known, particularly in monogamous species where both sexes contribute towards caring for the young. Previously, we have presented a behavioral system in which breeding male Leach's storm-petrels (*Oceanodroma leucorhoa*) avoid mating partnerships with females of reduced homozygosity at a specific genetic marker, the Major Histocompatibility Complex Class IIb. Here, we report breeding females to further exhibit wide variation in morphometric and microbial traits that significantly correlate with reproductive success and MHC genetic signatures. We used 16S rRNA Illumina Mi-Seq to investigate bacterial communities associated with the brood patch and uropygial glands, and found microbiomes and found microbiomes to vary significantly in females (Shannon diversity:  $p = 0.025$ ; beta diversity:  $p = 0.05$ ) but not in males. Wing chord measurements of adult females also differed with MHC heterozygosity ( $p=0.003$ ) and explained significant variation in the microbiota of female brood patches ( $p=0.024$ ). These results represent the first characterization of microbial communities on the skin and feathers of seabirds. Furthermore, these results suggest that the reproductive quality of female Leach's storm-petrels may be potentially signaled by morphometric and microbial traits associated with MHC genotype, and that both females and males play a selective role in mate choice.

## ANOMALOUS OCEAN CONDITIONS COINCIDE WITH A LACK OF NESTING ACTIVITY IN MARBLED MURRELETS IN OREGON

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The Marbled Murrelet (*Brachyramphus marmoratus*) is a threatened seabird that requires mature forest and adequate prey in the nearshore environment for successful breeding. Despite being listed under the U.S. Endangered Species Act in Washington, Oregon and California for more than two decades, the population is still declining. We established a large-scale, long-term study to address pressing questions related to space use and nest success of murrelets within Oregon, where nesting data are especially limited. In 2017, we captured and radio tagged 61 murrelets, and tracked these individuals from April – September to identify nest locations and quantify marine and terrestrial habitat use. Although we expected tagged murrelets to nest inland of capture locations in central Oregon none of the tagged individuals exhibited nesting behavior, a first for a study of this magnitude. Instead, a majority of individuals exhibited unprecedented long distance movements spanning >1200 km of coastline. We hypothesize that the anomalous ocean conditions present in Oregon during the 2017 breeding season reduced available prey resources, leading to long-distance movements by murrelets and an absence of nesting behavior.

## THE TRILATERAL ISLAND INITIATIVE: INTERNATIONAL COLLABORATIVE EFFORTS FOR THE CONSERVATION AND RESTORATION OF SEABIRDS IN NORTH AMERICA

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The countries of North America—Canada, United States of America, and Mexico—are inextricably linked through shared species, habitats, and ecosystems. Over the last several decades, significant efforts have been made to conserve marine birds and unique island ecosystems within the three nations. Marine birds have large geographic ranges that span political borders and their long-term conservation requires protection at their terrestrial breeding and marine foraging habitats. Significant conservation advances have been achieved through bi and trilateral collaboration. In 2014, the three countries' governments signed an agreement to protect fragile island ecosystems and its imperiled species. This agreement, endorsed under the scope of the Trilateral Committee for Wildlife and Ecosystem Conservation and Management, strengthens the on-going collaboration between the three nations on the conservation of island ecosystems and their adjacent coastal and marine environments. Through coordinated efforts, government and NGO partners are accelerating investment in island conservation programs across North America through the Trilateral Island Initiative with a focus on invasive species, biosecurity, restoration, and regulatory processes. Activities include prioritization of invasive species projects on a continental scale, sharing of expertise and technology, strengthening institutional capacities, and leveraging funding and support. These partnerships have accelerated seabird conservation outcomes across North America, including the eradication of invasive species in Canada and United States for the protection of rare seabirds and ecosystems, and a systematic and comprehensive program to conserve and restore islands in Mexico.

## FORTY YEARS AND COUNTING: UPDATE ON THE ECOLOGY AND CONSERVATION OF THE CRITICALLY ENDANGERED WAVED ALBATROSS

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Monogamy and stable population growth are expected of species whose life histories are characterized by high survival and slow reproduction and early work by Harris (1973) on the population biology of the waved albatross (*Phoebastria irrorata*) matched these expectations. Intense study of banded birds on Española in the early 2000s has revealed extensive extra-pair copulation behavior and an unexpectedly high degree of extra-pair paternity. Tests of hypotheses about genetic similarity between females, social mates, and cuckolding males suggest that females might choose mates to maximize genetic complementarity rather than avoid costs of inbreeding. Male participation may be related to the timing of their return to the colony to breed rather than accrue possible inclusive fitness benefits. Declines in adult survival – and concomitant declines in population size – of this species are thought to be associated with bycatch in small-scale fisheries near South America as well as El Niño events. A multistate mark-recapture analysis of Harris' historic dataset (1969-1979) and a contemporary dataset (1999-2012) of banded birds allowed us to evaluate hypotheses about changes over time in the impact these extrinsic threats have on survival and reproduction. Our best models suggest a continued decline in survival since 1999 which may be linked to changes in fishing activity but variation in sea surface temperature, plastic ingestion, and disease may also be important factors in this system.



## INSIGHT INTO THE ECOLOGY, POPULATION STATUS, AND LONG-TERM TRENDS OF CALIFORNIA LEAST TERNS IN SAN DIEGO COUNTY

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Continuing habitat loss and disturbance are among the most critical threats that hamper recovery of seabird populations globally. However, changing environmental conditions may be creating a complex suite of challenges impacting energy budgets, health, body condition, productivity and survival for populations that are already at risk. Historical data provide fundamental baselines to enable the evaluation of progress made towards recovery and to provide insight into how population parameters are changing. However, shallow time series can generate incomplete or inaccurate snapshots about the status of population parameters (shifting baselines). We summarize on-going analyses of three decades of data on productivity and population parameters of endangered California Least Tern (*Sternula antillarum browni*) in San Diego County. We discuss the environmental context of observed changes, and we provide overviews of monitoring methods and knowledge needs for guiding future research efforts.

## ARE FORAGING AREAS OF ADÉLIE PENGUINS AFFECTED BY NEIGHBORING COLONIES?

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Intra-specific competition would be an important factor affecting the foraging behavior of animals. Central place foragers, such as breeding seabirds, may face intense intra-specific competition near their colonies when the foraging areas of two or more colonies overlap each other. Previous seabird studies suggested that neighboring colonies segregated their foraging areas, but often lacked the appropriate 'null model' to examine the effect of neighboring colonies. Here, we examined the foraging areas of Adélie penguins *Pygoscelis adeliae* from two neighboring colonies by using bird-borne GPS loggers. The field study was conducted at Hukuro cove (104 nests) and Mizukuguri cove (338 nests) colonies, which located 2 km apart in Lützow-Holm Bay, Antarctica. We obtained the GPS tracks of 504 foraging trips from 47 chick-rearing birds, and then evaluated the overlap in the core and peripheral foraging areas (50% and 95% kernel densities) between two colonies. We also produced simulated movement tracks by using correlated random walk and evaluated the overlap in the simulated foraging areas. We compared the degree of overlap in the foraging areas from real tracks with that from simulated tracks to examine the effect of neighboring colonies on penguin movement. The results suggest that the peripheral foraging areas of both colonies overlapped extensively, but the overlap of the core foraging areas was significantly smaller in real tracks than in simulated tracks. We suggest that penguins from two neighboring colonies partially segregated their core foraging areas.

## CRYPTIC SEABIRD MORTALITY ON U.S. WEST COAST PACIFIC HAKE FISHING VESSELS

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Seabird mortalities caused by striking trawl warps and cables is a known source of cryptic mortality in trawl fisheries, resulting in underestimates of seabird bycatch in these fisheries. Because fishery observers do not routinely monitor cables for seabird interactions, they witness few seabird cable strikes. Furthermore, trawl nets and cables rarely capture injured or dead birds. Our goal was to identify and quantify the magnitude of bias in seabird mortality on Pacific hake at-sea catcher processor vessels that use midwater trawl nets and data transponder cables. Each observer monitored randomly selected cables at randomly selected times and documented strikes for the entire 2016 & 2017 fishing seasons. Observers also recorded variables associated with bird strikes, including strike characteristics, vessel operations, environmental conditions, and local bird species and abundance. All strikes (100%) occurred during offal discharge from the vessel. Higher strike rates were observed on vessels with a fish meal plant. Seabirds of conservation concern, including three species of albatross, occur on the US Pacific coast and interact with fisheries. Based on the 12 hard strikes of Black-footed Albatross (*Phoebastria nigripes*; BFAL) observed in the study in 2016, we estimate that there were ~400 BFAL hard cable strikes during the entire 2016 fishing season. In contrast, fishery observers on these vessels only documented two BFAL carcasses in 2016, suggesting a large bias in BFAL mortality estimates in this fishery. We are currently developing collaborative relationships with industry and other partners to develop mitigation for seabird cable strikes on West Coast trawl vessels.

## RECOMMENDATIONS FOR A TRAPPING PROTOCOL FOR ADULT LEAST TERNS.

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As part of studies of age structure of the California Least Terns (*Sternula antillarum browni*) we trapped at 1131 nests, with 466 terns trapped in 2016 and 2017. We used a drop trap placed over the nest for all captures at six sites in May and June. We recorded distance from the trap to observer, if a blind was used and the type, if pre-trapping was used, time of day, calendar week, year, weather conditions, and site. We analyzed the time (minutes, seconds) from when the trap was set to when the tern was trapped. Using ANOVA, no significant differences ( $N = 466$ ,  $DF = 465$ ,  $P > 0.05$ ) were detected for cloud cover, pre-trapping, time of day, year, weather and site. We detected significant differences ( $P < 0.05$ ) among use of blinds, distance categories and calendar week. Analysis using Tukey-Kramer indicated that trapping time was lower when trapping from a vehicle than with no blind or a camouflage tarp. Trapping time was lower when  $>100$  ft. (30 m) from the nest, followed by 50-99 ft. (15-30 m), and 1-49 (1-15 m). For calendar week, there was an overall declining trend between weeks 19-23, only weeks 19 and 21 compared to week 23 were significantly different. Based on this we recommend a trapping protocol that would allow for trapping throughout the day and nesting season, pre-trapping and the use of camouflage tarp and blinds may be unnecessary. It appears that there is a benefit in trapping from a vehicle at greater than 100 ft. from the nest. However, the difference in average trap times between the  $<49$  ft. and  $>100$  ft. categories is only 5 minutes 17 seconds. This likely does not create a larger impact to the nesting adult bird, therefore trapping at all distances should be allowed.

## VARYING PREY AVAILABILITY INFLUENCE THE DIETARY NICHE DYNAMICS OF THE SEABIRD ASSEMBLAGE ON THE NORTHEASTERN NEWFOUNDLAND COAST

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Shifting prey availability can lead to altered species interactions, indicated by variation in a species dietary niche breadth as well as dietary niche overlap among species. On the Newfoundland coast, an annual pulse of the dominant forage fish, capelin (*Mallotus villosus*), provides an excellent opportunity to investigate the influence of varying prey availability on dietary niche breadth and niche overlap among species. During June-August 2017 we investigated species-level and assemblage-level responses to shifting capelin availability for five breeding seabird species: Atlantic puffin (*Fratercula arctica*; n=44), razorbill (*Alca torda*; n=39), common murre (*Uria aalge*; n=40), Leach's storm-petrel (*Oceanodroma leucorhoa*; n=51), and northern fulmar (*Fulmarus glacialis*; n=15), as well as non-breeding great shearwaters (*Ardenna gravis*; n=27) and sooty shearwaters (*A. grisea*; n=24). To do this, we quantified stable isotope ratios ( $\delta^{15}\text{N}$ ,  $\delta^{13}\text{C}$ ) in seabird blood collected both before and after capelin arrived in the study area, and compared dietary niche breadth and overlap within a Bayesian framework. At the species-level, trophic position increased and dietary niche breadth narrowed for breeding species after capelin arrived, reflecting a more capelin-based diet. Similarly, trophic diversity, reflecting the variety of prey species consumed by the entire seabird assemblage, decreased after capelin arrived resulting in high dietary niche overlap among seabird species. Findings iterate the importance of capelin as a prey resource for both breeding and non-breeding seabirds in coastal Newfoundland and highlight potential changing species interactions and conservation concerns if capelin declines in biomass.

THE PERFUME OF PETREL PLUMAGE: INDIVIDUAL-SPECIFIC ODOR SIGNATURES IN LEACH'S STORM-PETRELS (*OCEANODROMA LEUCORHOA*)

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Leach's storm-petrels (*Oceanodroma leucorhoa*) have a remarkable sense of smell and a strong, musky scent. They mate for life and rely on scent cues to relocate their partner at the breeding colony. We investigated personal odors in Leach's storm-petrels as an important first step in identifying the chemicals that facilitate olfactory mate recognition. The secretions of the preen gland have received the most attention as a source of personal odor in birds. However, we chose to examine the chemicals associated with Leach's storm-petrel feathers since the plumage is the substrate that presents odors for assessment by conspecifics. To look for evidence of sex and individual-specific odor signatures, we collected feathers from over 50 individuals on Bon Portage Island, Nova Scotia, Canada in 2015 and 2016. To determine if personal odor is repeatable over time, we obtained samples from all birds in both years. Using gas chromatography-mass spectrometry, we examined the scent of the feathers to elucidate the chemical drivers of the personal odor signature. We found over 200 odor compounds on Leach's storm-petrel feathers; many of the compounds appear to be petrel-derived and have been found on the plumage of other Procellariiform seabirds. We also identified several non-bird derived chemicals, which likely originated from environmental pollutants. Multivariate analyses support differences in the relative proportion of odor compounds that delineate individuals and show that personal odor is consistent across multiple years. These findings suggest that Leach's storm-petrel feathers provide important scent cues that could facilitate olfactory recognition of conspecifics.

## HIGHLY-PRODUCTIVE INDIVIDUALS ASSOCIATED WITH HIGH SURVIVAL IN A CASSIN'S AUKLETS

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In traditional paradigms of life history theory, species increase lifetime reproductive output through a trade-off between investing in future survival and immediate reproductive success. This pattern may be obscured by a lack of longitudinal data, where confounding between- and within-individual variation in reproductive ability masks the effect individual quality has on these apparent trade-offs. The Cassin's auklet (*Ptychoramphus aleuticus*) is a seabird that challenges this paradigm, where some individuals produce two successful broods in a single season. Here, we analyze thirty years of breeding histories from uniquely marked known-age auklets to test whether double brooding increases lifetime fitness despite the increased mortality and reduced lifespan higher reproductive effort would be expected to incur. Multistate mark-recapture modeling revealed that double brooding was actually strongly positively associated with higher annual survival and drastically increased longevity. Mean (95% CI) annual apparent survival was 0.69 (0.21, 0.91) for individuals that executed a single brood and 0.96 (0.84, 0.99) for individuals that double brooded. Generalized linear mixed models indicated individuals that attempted multiple double broods over the course of their lives were able to produce on average seven times as many chicks and live nearly six years longer than birds that never attempted a double brood. Our results provide evidence that double brooding is associated with higher individual quality, and run counter to the idea of a trade-off between reproductive effort and survival in long-lived species.

## SEABIRD DISTRIBUTIONS AND RELATIVE ABUNDANCE IN THE CENTRAL AND EASTERN PACIFIC BASED ON AT-SEA SURVEYS, 1988-2017

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This effort drew on standardized seabird strip transect surveys conducted by the National Oceanic and Atmospheric Administration Southwest Fisheries Science Center over the period 1988-2017, to improve current knowledge of seabird distribution patterns in the Central and Eastern Pacific. Repeated sampling in four extensive sampling areas, the Eastern Tropical Pacific ( $2.1 \times 10^7$  km<sup>2</sup>), the California Current ( $1.1 \times 10^6$  km<sup>2</sup>), the Hawaii Exclusive Economic Zone (EEZ;  $2.4 \times 10^6$  km<sup>2</sup>), and the Palmyra/Johnston EEZs ( $2.2 \times 10^6$  km<sup>2</sup>), provided unprecedented geographic coverage and sampling density in subtropical and tropical areas of this region. In total these surveys encompassed 23,573 hours and 426,377 km of survey effort, and include 181,532 observations of 159 species. Seabird distribution patterns are presented in 1) density per day of survey effort, 2) gridded density, and 3) presence-absence. A handful of species showed broad cosmopolitan distribution patterns (e.g., Leach's-type Storm Petrels, *Oceanodroma leucorhoa* spp.), while other species showed affinities for specific water masses (e.g., Juan Fernandez Petrel, *Pterodroma externa* and tropical surface waters), as well as central place foraging distributions (Hawaiian Petrel, *Pterodroma sandwichensis*), and coastally-associated distributions (Black-vented Shearwater, *Puffinus opisthomelas*). Synoptic distributions detailed in this study complement recent advances in satellite and archival telemetry technologies, which provide rich detail at the individual-level, but face challenges in generalizing to population-level distributions due to 1) limited numbers of individuals instrumented, 2) geographic correlation of tagging locations, and 3) sparse taxonomic coverage.



## MERGING SEABIRD SURVIVAL MODELING AND FOOD WEB MODELS REVEALS MANAGEMENT TRADE-OFFS

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Ecosystem-based management aim to balance diverse use of marine systems and requires quantitative approaches to assess management options. Food web models or demographic models may be used, but it is rare that assessments merge insights from the two approaches. We used a 21-year capture-recapture dataset on Baltic Sea common murre (*Uria aalge*) and multi-state-survival models to find covariates affecting adult survival. Prey quantity – abundance as well as biomass of sprat (*Sprattus sprattus*), and survival had a positive relationship. Combined with simulations from an Ecopath with Ecosim food web model, it was possible to simulate murre survival rates under future scenarios for management of the main environmental issues in the central Baltic Sea: cod fisheries and eutrophication, while accounting for climate change. Our analysis revealed conservation trade-offs: The scenario so far generally considered the most desirable (reduced nutrient input and precautionary cod fishing) is likely to negatively impact the murre population due to effects cascading through the food web. Stronger impacts were projected in the near (2016-2040) than in distant (2060-2085) future. This modeling approach can be applied to many seabird populations whose demographics are monitored. The approach can quantify synergies or trade-offs associated with management options when effects may propagate through the food web. It could highlight population impacts stemming from predators or food resources, as well as aid in identifying cost-effective or redundant management measures.

## HABITAT USE OF TWO SLATY-BACKED GULLS DURING NON-BREEDING AND BREEDING SEASONS REVEALED BY GPS TRACKING: HIGH DEPENDENCY ON ANTHROPOGENIC HABITATS

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It is frequently observed that gulls use anthropogenic habitats and foods. We investigated habitat use of two Slaty-backed Gulls (*Larus schistisagus*) during non-breeding and breeding seasons in Hokkaido, northern Japan, by using GPS-cellular phone network-based telemetry systems which could record year-round positional data for two-hour intervals. After the GPS attaching at southern Hokkaido in mid-January 2017, one individual (ID1603) stayed there until early February (wintering period), then moved to 320 km east over 3 days. The gull stayed at the eastern Hokkaido until late April (pre-breeding period), then the gull moved to 10 km east and nested on the roof at a fisheries port until the end of August (breeding period). The other individual (ID1604) wintered at southern Hokkaido until the end of April, and then the gull was lost. During the wintering period, ID1603 and ID1604 spent 85 and 97% of their time respectively at the fisheries ports and fish processing industries. During pre-breeding period, ID1603 stayed at the fisheries ports and industries 67 % of the time. During breeding season, except for nest attendance, ID1603 stayed fisheries port within 1 km from the nest. Our results revealed that the gulls highly use the anthropogenic habitats throughout the season.

## MALE AND FEMALE BLACK-TAILED GULLS FEED ON THE SAME PREY SPECIES BUT USE DIFFERENT FEEDING HABITATS

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Sexual segregation in foraging habitats and differences in the diets are reported in many seabirds. These sexual segregations can be caused by sexual differences in competitive ability or nutritional requirement. We investigated diets of male and female Black-tailed Gulls (*Larus crassirostris*) by collecting regurgitation during incubation period and examined their foraging behaviours and habitat use by tracking their movements using GPS data-loggers. The regurgitations of both males and female included almost only Japanese sand lance (*Ammodytes personatus*). Females were more likely to take long foraging trips than males. Males frequently foraged in fisheries ports and fish processing industries, but females rarely did. Males favored nearshore areas (<50 m sea depth), while females expanded their foraging range to deeper areas near the ocean frontal zone. Sexual differences in foraging habitat use despite same prey in our study might be explained by competitive exclusion by males having larger body size and stronger competitive abilities than females, rather than by different nutritional requirement for each sex.

## THREATS OF INVASIVE RACCOONS TO BREEDING BLACK-TAILED AND SLATY-BACKED GULLS IN NORTHERN HOKKAIDO, JAPAN

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Recently the distribution of Raccoons *Procyon lotor* has been expanded worldwide. The invasive Raccoons can be potential predator for local seabird populations, however, the actual threat levels have not been sufficiently reported especially in Asia region. In Japan, Raccoons had been introduced as pets in 1980s, and to date those have become feral in several regions. In this study, we investigated threats of the invasive Raccoons to breeding Black-tailed (*Larus crassirostris*) and Slaty-backed Gulls (*Larus schistisagus*) of which populations are rapidly declining recently, at a colony in Esashi, northern Hokkaido, by using censor camera and fecal collection. A censor camera, which was set at the entrance of the colony during 16 days of chick-rearing period of the gulls, detected in total 59 times and 139 individuals of intrusions of the Raccoons, and 96% of those intrusions occurred in night time. This intrusion frequency was three times higher than that of Ezo Red Fox *Vulpes vulpes schrenck*, a native predator in this region. Three fecal of the Raccoons collected near the colony included feathers or bone of the gulls. At the end of the breeding season, the two thirds of all 3000 breeding pairs of the gulls abandoned their breeding probably because of predation mainly by Raccoons. This study indicates that urgent establishment of protection measures from the alien species is needed for restoration of seabirds in Japan.

## MEETING CHALLENGES FOR MONITORING SEABIRD BYCATCH ON SMALL LONGLINE VESSELS USING ELECTRONIC MONITORING TECHNOLOGIES

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The Alaska Fisheries Science Center (AFSC), National Marine Fisheries Service (NMFS), U.S.A., monitors Alaska groundfish fisheries catch and bycatch, including seabird bycatch since 1993. The AFSC is exploring electronic monitoring (EM) as a potential supplement or alternative to observers due to logistical and economic difficulties of accommodating observers on small vessels and the need to monitor from locations not suitable for an observer. We first pilot tested EM in 2002 on two studies: trawl vessel third wire seabird interactions and demersal longline halibut vessel bycatch and mitigation compliance. Mitigation measure compliance was quite successful but correct species identification varied between ca 10% and 76% based on EM attributes. Currently, Alaska fisheries are on a path to integrate EM into fisheries monitoring programs onboard small longline vessels. Research and development of new technologies has been in progress since 2014 to help address challenges where image quality can be greatly compromised by environmental conditions, light conditions, camera maintenance and limitations of current EM systems. The latest development in camera technology and computer vision may offer potential solutions. The AFSC is developing an EM system that incorporates multi-spectral cameras and machine learning to improve our ability to accurately identify seabird bycatch to appropriate species or species groups. Initial processing of over 250 birds (mostly Procellariids) indicates that these systems could greatly improve our ability to monitor fisheries.

TRENDS IN MAMMALIAN PREDATOR CONTROL TRAPPING EVENTS INTENDED TO PROTECT ENDANGERED HAWAIIAN PETREL ('UA'U, *PTERODROMA SANDWICHENSIS*) AT HALEAKALĀ NATIONAL PARK, HAWAII: 2000–2014

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Predation and habitat degradation by non-native species are principal terrestrial threats to endangered Hawaiian Petrel ('Ua'u, *Pterodroma sandwichensis*) and Hawaiian Goose (Nēnē, *Branta sandvicensis*) within Haleakalā National Park (HALE), Maui, Hawaii. Since 1981, HALE has maintained a network of live-traps to control invasive mammalian predators and protect these endangered birds. To continue evaluations initiated in 1993 and 2001 by HALE, we analyzed trap events at HALE 2000 – 2014. The types of trap events were “bait lost” (62%), “no event” (23%), “trap triggered” (10%), and “predator event” (captured rats, mongoose, and cats; 4%). Variations in the probabilities of no event, other event (bait lost or trap triggered), or predator event (rat, cat, or mongoose) were best explained by season (off-season, pre-laying, incubation, or nestling), month, year, and seasonal rainfall. Spatial analysis showed that percent vegetative cover and vegetation type best explained variations in the probabilities of no event, other event, or predator event. Among predator events, the proportion of rats caught was at least 20-times greater than the proportions of cats or mongoose caught throughout the 15-year study period. Temporal analysis in trap events showed season, year, and maximum temperature best explained variations in probabilities of predator events. Spatial analysis of predator events showed elevation best explained variations in probabilities of capture for rats, cats, and mongoose. Our results are being used by HALE Endangered Wildlife Management staff to evaluate existing methods for predator control and efficacy of trap-based control strategies intended to protect 'Ua'u and Nēnē.

## RESTORATION PROJECT FOR SWINHOE'S STORM-PETRELS IN KOREA NATIONAL PARK

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Breeding colony of seabirds is vulnerable to invasive species. In South Korea, more than 75% of the world population of Swinhoe's storm-petrels (*Oceanodroma monorhis*) breeds on two small islands such as Guguldo Island and Chilbaldo Island. Swinhoe's storm-petrels are protected as a 'Near Threatened' species on the IUCN Red List of Threatened Species. Main threat of them is an invasive plant, the Japanese chaff flower *Achyranthes japonica*. Seeds of *A. japonica* easily stick to feathers of birds. Swinhoe's storm-petrels which have relatively long wings can be even trapped to die by *A. japonica*. We monitored breeding population of Swinhoe's storm-petrels on Chilbaldo Island for 4 years (2013~2016). Over 400 individuals of 10,000 pairs died due to *A. japonica*. It means approximately 2% of breeding population reduced each year. To avoid the impacts of invasive plants, the restoration project was started in 2015 by National Park Research Institute, Dadohaesang National Park Western Office, Namdo Ecology Research Institute and Sinan County. First, we identified core sites where *A. japonica* highly distributed and secondly, removed the plants and replaced them to Coastal rock sedges *Carex boottiana* which Swinhoe's storm-petrels preferred as a nesting site. The Coastal rock sedge had been cultivated and transferred to Chilbaldo Island. In 2016, the number of dead birds rapidly declined and replanted area slowly recovered. Swinhoe's storm petrels started to make their nests in invasive plant free area. We will monitor breeding population of Swinhoe's storm-petrels on Chilbaldo Island to investigate the long-term effect of invasive plant control.

## COLONY AND NEST-SITE SELECTION BY ROSEATE TERNS (*STERNA DOUGALLII*) IN CANADA

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The Canadian Roseate Tern (*Sterna dougallii*) population is Endangered; it has historically been small but stable at around 75-100 pairs although only 55 pairs were reported breeding in 2017. Also, the number of relatively large Canadian colonies (15 pairs) has declined of late, going from 10 in the late 1990s to three in 2017: North Brother Island and Gull Island in SW Nova Scotia (NS) and Country Island in E NS<sup>4</sup>. The small number of important colonies make the Canadian Roseate Tern population particularly susceptible to disturbances related to climate change, most notably increased flooding and erosion of nesting habitat due to higher water levels. As outlined in the Roseate Tern's national recovery plan, to save this population, it is imperative that we understand important characteristics of nesting habitat.

I will complete a hierarchical habitat selection study for Roseate Terns in southwest Nova Scotia. The first part of my thesis will test habitat selection theory (e.g., that Roseate Terns select nesting habitat non-randomly) at three spatial scales. I will first identify abiotic and biotic characteristics that influence island-level selection by both Common and Roseate Terns. Next, I will examine the characteristics influencing the selection of sub-colony sites by the two species. Finally, I will study the characteristics of nest-site selection for both species, and for natural and managed (nest boxes) situations for Roseate Terns. The second part of my thesis will develop of a biotic and abiotic habitat suitability guide for the Canadian Roseate Tern population. My research will contribute original information on habitat selection by endangered Roseate Terns in a marine environment heavily affected by climate change.



## CORTICOSTERONE AS A BEHAVIORAL DRIVER AND NUTRIENT RESPONSE IN TWO SYMPATRIC ALBATROSSES

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Corticosterone, a glucocorticoid hormone, maintains energy balance and can modulate foraging behaviors in seabirds; however, responses are not always predictable under similar biophysical conditions and do not necessarily influence the same behaviors across breeding stages and species. To enhance our understanding of the role of corticosterone as a proximate determinant of foraging behavior and energy maintenance, we examined the relationships between body condition, corticosterone, foraging behavior, and foraging success among two sympatric breeding albatross species with differing foraging strategies and life histories: the Campbell albatross (*Thalassarache impavida*) and the grey-headed albatross (*T. chrysostoma*) from Campbell Island, New Zealand. Pre- and post-foraging corticosterone did not differ between species or stage, potentially as a result of behavioral plasticity or different functional roles of corticosterone across stages. Unexpectedly, body condition did not correlate with pre-foraging corticosterone during incubation, though a negative correlation was observed in guard-stage Campbell albatrosses. Furthermore, corticosterone mediated foraging success in both species and stages, but there was no relationship between corticosterone and specific foraging behaviors. However, corticosterone positively correlated with mass gain and the time elapsed since the last feeding event in guard-stage albatrosses. Our results highlight the complexity of corticosterone in mediating energy balance in free-ranging animals. They also suggest that if corticosterone is to be usefully interpreted, timing must be considered as the physiological and behavioral functionalities of corticosterone may differ across breeding stages.

## SEABIRD COMMUNITIES OF THE PACIFIC ARCTIC AND THE DISTRIBUTED BIOLOGICAL OBSERVATORY- A BROAD SCALE MONITORING ARRAY

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To detect change in the Pacific Arctic, eight Distributed Biological Observatory (DBO) sites, sampled by vessel-based, international science programs, extend from the northern Bering to the eastern Chukchi and western Beaufort seas. They were established on the basis of benthic diversity and abundance, but now incorporate upper trophic levels such as seabirds. We used at-sea visual surveys totaling ~115,860 km of transects from 2007-2015 to compare seabird species richness, community composition, and relative abundance among these DBOs and to their surrounding regions. We also examined the influence of location and water mass on the seabird community. Seabird community composition of each DBO was representative of its greater respective region (northern Bering, eastern Chukchi, western Beaufort), although the two or three DBO sites within a region captured different community components, and no DBO fully sampled all potential species within a region. Species richness (totaling 59 species) was higher in the northern Bering than in the Chukchi and Beaufort regions, peaked near Bering Strait, and dropped steeply north of 72°N. For 11 of 12 taxa within DBOs, and 9 of 12 taxa in the greater Regions, variance in abundance was greater among DBO sites than among Years. Taxa with greater interannual variance were shearwaters, murrelets, and phalaropes - late summer migrants to the study area. We identified six community types across all regions, which roughly corresponded to current systems (e.g., Alaska Coastal Current, Anadyr Current) or oceanographic domains, with breeding colony distribution also influential. Results will inform future sampling efforts, interpretation of observations, and management decisions.

## MOVEMENT PATTERNS OF CALIFORNIA BROWN PELICANS (*PELECANUS OCCIDENTALIS CALIFORNICUS*) FOLLOWING OILING AND REHABILITATION

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Direct mortality of wildlife is generally used to quantify the damage caused by pollution events; however, non-lethal exposure may also have long-term consequences for free-ranging wildlife. Individuals admitted to rehabilitation facilities following pollution events have a known history of oil exposure and provide a useful study population for understanding behavior following oiling and rehabilitation. We used bird-borne GPS telemetry to track 12 rehabilitated California Brown Pelicans (*Pelecanus occidentalis californicus*) and compared their movements and behavior to those of eight non-oiled, non-rehabilitated controls. Pelicans that had experienced oiling and rehabilitation traveled greater distances, spent more time in long-distance movement, and occupied more productive marine habitats than did controls. These differences were more apparent among females than males. The oiled and rehabilitated group also visited breeding colonies and attended apparent nest sites at lower rates than controls. Our results indicate that, although previously oiled pelicans are able to survive and undertake long-distance movements following rehabilitation, they may display a reduced investment in breeding relative to self-maintenance, which could have long-term effects on population dynamics following pollution events.

THE PUGET SOUND SEABIRD SURVEY: DOCUMENTING LIVE SEABIRD ASSEMBLAGES IN THE PUGET SOUND, WASHINGTON USA USING CITIZEN SCIENCE

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For over a decade dedicated volunteer citizen scientists have taken part in the Puget Sound Seabird Survey (PSSS) a monitoring program that aims to investigate seabird diversity and abundance throughout the Puget Sound and Southern Salish Sea, Washington. Initially established with 32 survey locations and 30 volunteers, the program has grown to include 122 waterfront survey sites where more than 200 trained volunteers identify, quantify, and collect data on seabirds in nearshore habitats. From these abundance, diversity and absence/presence data, we continue to learn about migration phenology, biodiversity and hotspots where different seabird species assemblages aggregate within the Puget Sound and Southern Salish Sea. With increased oil transportation across the Salish Sea, our data and volunteer network have also enabled the program to create an oil-spill preparedness and response plan that can be activated in the event of a major oil spill in order to aid in directing response infrastructure.

HABITAT CHARACTERIZATION OF THE ENDANGERED HAWAIIAN PETREL (*PTERODROMA SANDWICHENSIS*) ON LEEWARD HALEAKALĀ, MAUI

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The largest Hawaiian petrel (*Pterodroma sandwichensis*; HAPE) colony nests in alpine and sub-alpine shrub habitat on Haleakalā. The majority of the colony is within the crater district of Haleakalā National Park; however, birds nest on the leeward slope in the Nakula and Kahikinui Reserves. Following ungulate exclusion from the reserves in 2014, the number of active HAPE burrows has increased. Our objective is to determine what characteristics influence burrow site selection within Nakula/Kahikinui, and to document the response of the vegetation community and the HAPE colony to ungulate removal. Burrow site selection on other islands is primarily influenced by canopy and native plant cover; these habitats are wetter, at lower elevation, and have a different vegetation community than leeward Haleakalā. We predict that topographical features of the landscape will best predict burrow locations at this site. We are conducting annual vegetation surveys at randomly generated permanent plots and burrow sites. Variables include percent cover for all species (standard Relevé method), slope, aspect, altitude, surficial geology, and burrow height/width. Results from 2017 indicate that native species are more abundant and evenly distributed ( $n=24$ ,  $E=0.66$ ) than introduced species ( $n=23$ ,  $E=0.41$ ). Non-native species (grasses) have greater coverage than native species in certain low-elevation areas, while native shrubs are dominant at burrow sites. These data are the first attempt to characterize the habitat community within the fenced reserves. We will use the results to increase effectiveness of burrow searching, and to document habitat regeneration. Continued monitoring on leeward Haleakalā will inform reserve management strategies and HAPE protection.

## MASKED BOOBIES' FORAGING BEHAVIOR IN THE WORLD'S LARGEST OCEANIC DESERT

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The South Pacific Gyre has the most hyper-oligotrophic waters in the world and is considered to be the largest oceanic desert. How seabirds inhabit this gyre is still poorly known. Easter Island lays in the South Pacific Gyre, and a colony of Masked boobies (*Sula dactylatra*) is present in one of its islets. To study how Masked boobies from Easter Island forage in the gyre system we attached GPS and TDR devices on 19 and 9 individuals, respectively, during the 2016 and 2017 breeding seasons. To explore possible inter-annual differences in the foraging areas of Masked boobies, we employed remotely sensed sea surface temperature and chlorophyll-a concentration to characterize habitat preferences. We found no specific areas where boobies were travelling to or diving more intensively. Foraging parameters differences occurred at the individual level, and were similar between seasons. Compared to Masked booby colony elsewhere in the world, maximum distance from the colony was among normal ranges. Environmental variables did not differ among years in the areas used by boobies. Our results suggest that Masked boobies on Easter Island are using a prospecting tactic that includes all the areas they can access, a tactic that has been observed to be used by other seabird species relying on unpredictable resources. This tactic may allow them to maintain their foraging trips on normal ranges even in these low productive waters. Our results highlight the plasticity of this species to adapt their foraging behavior to local environmental conditions. This plasticity may be characteristic of the genus, and allow Masked boobies to be widespread in the Pacific.

## GENETIC DIVERGENCE BETWEEN FLESH-FOOTED SHEARWATER (*ARDENNA CARNEIPES*) COLONIES EXHIBITING DIFFERENT FORAGING BEHAVIOUR

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Increasing evidence suggests foraging segregation as a key mechanism promoting genetic divergence within seabird species. However, testing for a relationship between population genetic structure and foraging movements among seabird colonies can be challenging. Telemetry studies suggest that Flesh-footed Shearwater *Ardenna carneipes* that breed at Lord Howe Island or New Zealand, versus southwestern Australia or Saint-Paul Island in the Indian Ocean, migrate to different regions (North Pacific Ocean and northern Indian Ocean, respectively) during the non-breeding season, which may inhibit gene flow among colonies. In this study, we sequenced a 858-base pair mitochondrial region and seven nuclear DNA fragments (352–654 bp) for 148 individuals to test genetic differentiation among colonies of Flesh-footed Shearwaters. Strong genetic divergence was detected between Pacific colonies relative to those further West. Molecular analysis of fisheries' bycatch individuals sampled in the Sea of Japan indicated that individuals from both western and eastern colonies were migrating through this area, and hence the apparent segregation of the non-breeding distribution based on telemetry is invalid and cannot contribute to the population genetic structure among colonies. The genetic divergence among colonies is better explained by philopatry and evidence of differences in foraging strategies during the breeding season, as supported by the observed genetic divergence between Lord Howe Island and New Zealand colonies. We suggest molecular analysis of fisheries' bycatch individuals as a rigorous method to identify foraging segregation, and we recommend the eastern and western *A. carneipes* colonies be regarded as different Management Units.

## DOES RESEARCHER PRESENCE AT ALEUTIAN TERN BREEDING COLONIES CAUSE INCREASED NEST DEPREDATION RATES IN YAKUTAT, ALASKA?

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For the past several decades, recent data indicate drastic declines of Aleutian terns (*Onychoprion aleuticus*) at known colony sites. To investigate possible causes of decline, remote cameras were deployed at Aleutian tern nests within colonies near Yakutat, AK, to document breeding behaviors, nest success rates, and causes of nest failure. High nest depredation rates were observed throughout the colony and photo revealed common ravens (*Corvus corax*), coyotes (*Canis latrans*), and bald eagles (*Haliaeetus leucocephalus*) predating on nests. To investigate if researcher movement within the colony was possibly attracting predators, a 'simulated colony' was developed about 300m from active nests in an area with little evidence of prior predator activity. This colony consisted of 10 nest scrapes containing a single plastic egg painted to mimic an Aleutian tern egg. Trail cameras revealed that common ravens were the only predator to attack and destroy the artificial eggs. In comparison to the live colonies, the simulated colony survival was the longest. Photo captures of large mammals and other predatory birds did occur within the simulated colony however, these pictures were unfocused due to the animal rapidly passing by the camera, and it appears these species lacked interest in the nests. Our data indicate that ravens may cue on human disturbances to identify areas and visually search for nests. Other predators may have entered the area following human disturbance, but were unsuccessful locating the artificial nests and may require additional cues for example, presence (e.g., flush) of an adult tern to precisely identify nest locations.



## TOWARDS A PACIFIC MONITORING NETWORK FOR A HIGHLY MIGRATORY SPECIES, THE PINK-FOOTED SHEARWATER

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The Pink-footed Shearwater (*Ardenna creatopus*) is globally listed as Vulnerable by the International Union for the Conservation of Nature (IUCN) and included in Appendix I of the Agreement for the Conservation of Albatrosses and Petrels (ACAP). To protect this highly migratory species, conservation measures are needed throughout its annual cycle, both on breeding colonies and at-sea. Studies of the migratory, foraging and reproductive patterns of Pink-footed Shearwaters have been fundamental to understand threats and develop effective conservation actions. The species breeds only in Chile and migrates to Peruvian and North American waters from May to November. It utilizes continental shelf and shelf-break habitat, with 82% of its non-breeding time spent in the territorial waters of seven countries. Recent studies have demonstrated strong interactions between Pink-footed Shearwaters and purse-seine fisheries in Chile, with this fishery increasingly recognized as a significant at-sea threat. The species also interacts with purse-seine fisheries along its migratory route, including waters of Ecuador, Peru and Mexico. Advancing our understanding of fisheries interactions in the territorial waters of other countries is a high priority. We have begun to develop a network of scientists, government agencies and conservation organizations to monitor highly migratory seabird species that use the waters of eastern Pacific boundary currents. Such a network will facilitate the collection, analysis and data sharing of fisheries impacts and other at-sea threats, as well as threat assessment and management between countries, and the development of informed country-specific and large-scale flyway conservation plans.

## HABITAT SUITABILITY FOR LAYSAN ALBATROSS AND BLACK-VENTED SHEARWATER IN THE MEXICAN PACIFIC OCEAN

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The Marine Important Bird Areas (Marine IBAs) are an international initiative to effectively protect seabirds and their oceanic habitats. Habitat modelling is a fundamental component in this initiative as it incorporates seabird distribution data and habitat characteristics to identify potentially suitable areas. However, there are currently no Marine IBAs identified in Mexico. In this study, we estimated habitat suitability using tracking data of the Laysan Albatross (*Phoebastria immutabilis*, LAAL) breeding on Guadalupe Island from 2014-2017, and the Black-vented Shearwater (*Puffinus opisthomelas*, BVSH) breeding on Natividad and San Benito islands from 2016-2017. This data was coupled with various habitat variables related to seabird distribution (e.g., Chl-a, SST, distance to the colony, etc.). The habitat suitability model was built using logistic regression and evaluated over the Pacific Ocean to identify areas with environmental characteristics similar to those within the 50% kernel density area calculated from tracking data. Preliminary results indicate that the coast from the northern Baja California peninsula to the Gulf of Alaska characterizes the most suitable habitat for LAAL, while the coast along the Baja California peninsula to southern California is the most suitable habitat for BVSH. This study is part of the first steps of an inter-institutional initiative towards identifying Marine IBAs in Mexico.

## DIVING ACTIVITY AND MOVEMENTS OF NON-BREEDING COMMON MURRES (URIA AALGE) DURING TWO YEARS OF CONTRASTING OCEAN CONDITIONS

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Changes in foraging behavior of marine predators have implications for population dynamics and community structure. The recent anomalously warm conditions (late 2013 -2016) in the North Pacific present an opportunity to better understand behavioral responses to an abrupt change in the environment. The common murre, an abundant upper-tropic level predator, would be expected to compensate for poor conditions by adjusting its foraging patterns. In this study, we used satellite transmitters coupled with saltwater sensors to study the large-scale movement patterns and diving activity of murrelets off the Oregon Coast, under relatively normal conditions in 2013 and anomalously warm conditions in 2015. We assessed movements by quantifying distances traveled per day and diving activity, in terms of hourly dive frequency and duration. Murrelets in this study were not constrained to a colony (i.e. were apparently failed or non-breeders). Preliminary results indicated that murrelets made longer duration dives, and dove less frequently during crepuscular periods and nighttime than during the daytime. Despite oceanographic differences, dive frequency and duration were similar between years. Daily traveling distances were greater in 2015 (9.4 km) than in 2013 (3.8 km). In both years, murrelets made extensive use of northern California Current Ecosystem, preferring shelf habitat to deeper waters, with high use areas in the Salish Sea and Columbia River plume. The change in daily travel distances between years, despite consistency of diving patterns suggests non-breeding murrelets were able to relocate and search for favorable habitats during poor conditions; however, behavioral responses among actively breeding murrelets remain unknown.

## INVESTIGATING ALEUTIAN TERN BREEDING AND FORAGING ECOLOGY USING SATELLITE TELEMETRY

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Observed numbers of Aleutian Terns (*Onychoprion aleuticus*) at known breeding colonies in Alaska have dramatically declined over the last several decades (Renner et al. 2015). To further interpret these data, we investigated the use of satellite telemetry to observe breeding season movements. Fifteen Aleutian Terns were fitted with 2g satellite telemetry tags early in the 2017 breeding season (n = 8 near Dillingham and n = 7 near Yakutat) and eleven tags provided movement data throughout the breeding season. Tagged terns exhibited moderate scale movements, with the maximum distance from their respective capture sites ranging from 42 to 282 km by individual. No tagged terns displayed extended fidelity to their capture location and follow-up surveys indicated nest and/or colony failure at both sites, presumably due to a large suite of documented predators. In the Yakutat area, tagged terns visited the majority of previously documented colony sites and spent extended periods at locations with active nesting. In the Dillingham area, movements of tagged terns indicated several previously undocumented colony sites, with successful fledging in at least two locations. Tern foraging activity was focused in marine and brackish waters. Around Yakutat, terns foraged across the continental shelf with some trips to the shelf break up to 100 km offshore. Around Dillingham, terns foraged closer to shore and in the estuarine habitats of Bristol Bay. Our initial results demonstrate that sufficiently miniaturized satellite telemetry tags are useful tools to study movements of Aleutian Terns and can help assess within-season colony attendance patterns, identify previously unknown colony sites, and help characterize important foraging habitats.

## PREDATOR MANAGEMENT TECHNIQUES FOR THE PROTECTION OF FEDERALLY LISTED BEACH NESTING SPECIES

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Predation of nests and nestlings by native and non-native predators remains a major area of concern for the recovery of both the federally endangered California Least Tern (*Sternula antillarum browni*) and federally threatened Western Snowy Plover (*Charadrius nivosus nivosus*) populations. Previous studies have shown that predator control programs, initiated for the protection of beach nesting shorebirds from both avian and mammalian predators, have been successful in increasing hatching and fledging success. Of the total tern and plover predations on Naval Base Coronado during the 2012-2017 nesting seasons, corvids were responsible for 60.7%, raptors 25.7%, mammals 7.3%, and 6.3% for other predators. We focused the majority of our efforts on the management of corvids in the areas surrounding tern and plover nesting grounds. We used non-lethal techniques, such as translocation and conditioned taste aversion, for management of native predators when possible, as well as lethal methods directed primarily at non-native predators found at Naval Base Coronado. We are currently exploring new innovative control methods that can be used to deter native predators occupying nesting grounds of sensitive shorebird species, which may reduce the amount of lethal control necessary to effectively manage predators for the recovery of listed shorebird species.

POPULATION DECLINE AND NEW NESTING SITES OF MAGNIFICENT FRIGATEBIRD (*FREGATA MAGNIFICENS*) IN BAJA CALIFORNIA SUR, MEXICO

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The Magnificent Frigatebird (*Fregata magnificens*) is a tropical seabird whose population is estimated between 59,000 and 71,000 pairs, with downward trends. In Mexico, the most important site documented was Estero Las Tijeras (20,177 pairs in 1986). We explore the most important current sites for the reproduction of this species in the state. In 2015 and 2017 we visited Magdalena Bay and in 2015 Espiritu Santo Island. In 2015, we recorded 1,211 individuals in Magdalena Bay, 88% in Estero Las Tijeras, representing only 3% of the numbers indicated 30 years ago. In the same year we observed 2,380 on Espiritu Santo Island. In 2017 we recorded 1,712 individuals in Magdalena Bay and found two new breeding colonies in Santo Domingo Chanel, both with few pairs. Among all the colonies visited we recorded only 1,334 pairs. In Estero Las Tijeras through satellite images (2003, 2009 and 2017) we noticed an evident degradation of the state of the mangrove (2003 to 2009), a situation that has remained to date. The decrease in the number of pairs could represent a loss of between 26% and 32% of the total population of the species. The fragmentation of the reproductive colonies can lead to greater vulnerability. Given the connectivity between the colonies of western Mexico, it is possible to assume that, if the conditions at Estero Las Tijeras improved, this colony could increase its number again.

## THE NEED FOR IMPROVED AND RESPONSIBLE PROTOCOLS FOR SEABIRD MONITORING

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Seabirds have some of the most delicate life cycles because many of them achieve sexual maturity after several years, procreate a few young, depend on suitable nesting areas and must overcome growing threats both in land and sea. Mounting evidence around the globe indicates that anthropogenic impact caused by researchers and eradication practitioners has become a serious but commonly ignored threat for seabirds. For instance, events of impacts on Newell's shearwater (*Puffinus newelli*), Audouin's gull (*Ichthyaetus audouinii*), Kentish Plover (*Charadrius alexandrinus*) in different areas of the world or Townsend's shearwater (*Puffinus auricularis*), Black-vented Shearwater (*Puffinus opisthomelas*) in México should prompt the scientific community to request improved and responsible protocols for seabird monitoring based primarily on ethical and conservation grounds. These protocols should determine the suite of actions that could be implemented in each particular case based on the level of endangerment of the species under study, explicit care and protection of breeding grounds and nesting birds, timing of monitoring, explicit guidelines for handling birds depending on their age and environmental condition, anti-predator measurements, impact of artificial devices placed in the breeding grounds, and explicit metrics to quantify the level of impact caused by the observer. Also, independent and objective evaluations of the impact caused by eradication campaigns on islands must be implemented to verify that actions taken do not have negative impacts on the endemic and threatened species they aim to protect in the first place. These protocols are of the utmost importance for critically endangered species where small demographic stochasticity could lead to an extinction vortex.

## ANNUAL COMPARISON OF FORAGING BEHAVIOR OF STREAKED SHEARWATERS IN RELATION TO MARINE ENVIRONMENT

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It is important for seabirds to respond to marine environmental change flexibly and to obtain enough prey for themselves and their chicks in order to succeed their breeding in each year. Therefore, they might change their foraging habitat and foraging behavior according to sea surface temperature and/or productivity to increase foraging efficiency. We attached GPS data-loggers on back feathers of streaked shearwater (*Calonectris leucomelas*) breeding on Awashima Island in the Sea of Japan during chick-rearing period and recorded 1343 foraging trips from 280 birds in 2009–2016. Foraging habitats and trip durations differed between the years. Although the marine environmental conditions differed among the years in terms of the sea surface temperature and the chlorophyll-*a* concentration obtained from the satellite remote sensing, foraging behavior did not correlate with both the sea surface temperature and the chlorophyll-*a* concentration. Our results indicate that the foraging behavior in the shearwaters could not be explained simply by sea surface temperature and chlorophyll-*a* concentration changes. Hence, it is necessary to investigate the relationship between the behavior and various environmental parameters.



## BREAKING THE ICE: GREAT BLACK-BACKED GULL (*LARUS MARINUS*) FORAGING BEHAVIOUR WHEN ENCOUNTERING SUDDEN CHANGE IN ICE CONDITIONS

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In North America, the breeding range of Great Black-backed Gulls (*Larus marinus*) extends from Virginia to Greenland. Across this latitudinal gradient, these gulls are exposed to very different environmental conditions that can change radically during a breeding season, thereby influencing foraging and provisioning behaviour of parents. To assess the foraging behaviour of Great Black-Backed Gulls, we deployed GPS loggers on three incubating individuals on the northeast Newfoundland coast during June 2017. Unusually concentrated multi-year ice moved within foraging ranges during early June, dividing the tracking period (17-21 days) into ice-free (5-10 days) and ice-presence periods (11-12 days), with percent ice cover ranging from 20-100%. For each foraging trip, we quantified trip parameters (e.g., distance, duration) and habitat use, defined as the number of foraging/roosting locations (i.e. speeds <4 km/h) per habitat type (i.e. coastal, marine, island, inland, inshore ice and offshore ice). Trip parameters did not differ between ice periods except for the mean distance from shore, which increased during ice-presence. Birds also showed a higher use of marine and offshore ice habitats and lower use of island habitat during ice-presence. A total of 73% of foraging/roosting locations associated with ice were in areas with  $\leq 50\%$  ice cover, whereas birds travelled (i.e. speeds >4 km/h) more through areas with >50% ice cover (29% of locations) relative to areas with <50% ice cover (19%). In conclusion, although ice cover influenced the use of habitat types by Great Black-backed Gulls, individuals primarily used areas of lower percent ice cover to forage/roost, suggesting that these may be important at-sea foraging/roosting sites for this top predator.

## RESTORING THE NATIVE PLANT COMMUNITY ON SCORPION ROCK TO ENHANCE NESTING HABITAT FOR BURROW AND SHRUB-NESTING SEABIRDS IN THE CALIFORNIA CHANNEL ISLANDS: LESSONS LEARNED OVER A DECADE 2007-2017

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Invasive, non-native plant species introduced to California's Channel Islands can affect seabird nesting habitat quality and threaten population growth and recovery. Scorpion Rock, located off the northeast end of Santa Cruz Island in Channel Islands National Park, is an important seabird nesting and roosting location. A legacy of human use and visitation allowed the spread of invasive, non-native plant species on Santa Cruz Island and adjacent Scorpion Rock. The altered vegetative cover contributed to decreased abundance and quality of nesting habitat for the burrow-nesting Cassin's Auklet (*Ptychoramphus aleuticus australis*) and crevice- and shrub-nesting Scripps's Murrelet (*Synthliboramphus scrippsi*). The removal and control of non-native vegetation and outplanting of >9,000 native plants from 2008 – 2017 has dramatically changed the landscape of Scorpion Rock. In 2008, vegetative cover was initially 94% invasive weeds (6 exotic species, mostly crystalline iceplant [*Mesembryanthimum crystallinum*]). Since 2011, percent native plant cover has remained consistent at ~60% cover, up from only 6% since 2007. Removal of non-native, invasive vegetation and the restoration of a native perennial Coastal Sage Scrub community on Scorpion Rock is providing better soil structure, nesting conditions, and cover for burrow- and shrub-nesting nesting seabirds, as well as new habitat for invertebrates and passerines. Lessons learned, evaluation of project methods and the development of remote-site-restoration-techniques from this effort have also benefited other habitat restoration projects on the California Islands for seabirds and other vegetation communities.

## OCEANOGRAPHIC DRIVERS OF PREY AVAILABILITY IN TROPICAL SYSTEMS: RESPONSES OF UPPER PREDATORS TO EDDIES AND FRONTS

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Adequate conservation and management of remote oceanic food resources is only possible with accurate knowledge of important foraging locations and the mechanisms that enhance food availability at these sites. Pelagic foraging seabirds are ideal models to identify and characterize processes or features important to many top predators. Compared with temperate marine environments, less is known about mechanisms driving prey availability in the tropics. We obtained data on the oceanographic characteristics of pelagic foraging sites used by wedge-tailed shearwaters (*Ardenna pacifica*) breeding in the Southern Great Barrier Reef (GBR), Australia, using PTT satellite transmitters over four breeding seasons. Pelagic foraging trips terminated in the Coral and north Tasman Seas at locations between 300km and 1400km from the breeding colony. Site use varied among years but specific locations were reused within and among seasons. In contrast to findings in other temperate and tropical systems, foraging activity was not correlated directly with elevated primary productivity, but was most strongly influenced by low to moderately positive sea-level anomalies and moderate current speeds occurring close to rapidly changing bathymetry, near seamounts. Combined, these characteristics identify the importance of prey enhancement occurring at meso-scale convergences and eddy peripheries adjacent to seamounts, independent of identifiable surface productivity. Importantly, these findings highlight the potential inadequacies of the current practice of using surface productivity as the principal index for identifying important foraging resources and the likely influence of climate-driven variation on food availability in tropical systems.

## PASSIVE ACOUSTIC MONITORING OF BONIN'S PETREL AT BREEDING SITES ON MIDWAY ATOLL

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Passive acoustic surveys have been shown to be an effective method for estimating breeding densities of colonial seabirds. The approach relies on passive acoustic sensors to record ambient sounds at surveys sites and machine learning techniques to automate the detection and quantification of acoustic activity rates of target species. Here we test whether passive acoustic surveys can be an effective technique for monitoring Bonin Petrels (*Pterodroma hypoleuca*) at the Midway Atoll National Wildlife Refuge. Bonin Petrels nest in underground burrows, and only return to colony sites at night. Measuring burrow occupancy through traditional count methods is time consuming and potentially detrimental, as dense aggregations of breeding burrows built in friable soils collapse easily under field observers. Less invasive methods to assess breeding densities and track population trends would be beneficial for managers. We conducted passive acoustic surveys and traditional burrow counts at 7 plots over two seasons on Midway Atoll (2015-2016, 2016-2017) to test the relationship between acoustic metrics of Bonin Petrel activity (mean calls per minute) and breeding densities. We found that measures of acoustic activity were significantly correlated with Bonin Petrel breeding densities over a range of different plot sizes, but that the relationship was tied to specific date ranges. In addition, low density plots had significantly higher call rates than would be predicted by the overall linear relationship. We explore the implications of these factors on designing replicable and scalable acoustic monitoring protocols for this species.

## PREY SIZE AND DELIVERY RATE OF COMMON MURRES (*URIA AALGE*) IN CENTRAL OREGON.

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The Yaquina Head Outstanding Natural Area (YHONA) colony of Common Murres (*Uria aalge*) has been a site of ongoing research and monitoring since 1998. In previous decades, four murre colonies in the northern California Current were intensively monitored; now the YHONA colony provides the only long-term data set for the Washington and Oregon coasts (837 km). As abundant and observable consumers, Common Murres can provide insight into the health and stability of the surrounding coastal ecosystem. Monitoring their rate of prey delivery to chicks and the quality (size) of delivered prey can be an indicator of forage fish availability and condition through time, and help assess bottom-up impacts on murres and many other upper-trophic level consumers. Two data sets, collected from 2010 to 2017, were used to assess foraging conditions: 1) prey identification and length estimation and 2) hourly prey delivery rate to chicks, across two main sub-colonies. In total, these datasets encompass over 500 meal deliveries and 2,600 identified fish. Prey delivery rate varied little across years, though taxonomic diversity and fish length declined across the study, especially during 2015-2017. In years when prey were smaller on average, delivery rate sometimes increased to compensate (e.g., 2015), but did not in other years, likely indicating particularly poor foraging conditions (e.g., 2016). Understanding the feeding ecology of Common Murres will deepen our knowledge of crucial prey types for colony success and enhance our understanding of food web dynamics along the Central Oregon Coast.

FIRST BREEDING SITE RECORD OF HORNBY'S STORM-PETREL (*OCEANODROMA HORNBYI*)  
ATACAMA DESERT, CHILE

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Hornby's Storm-petrel (*Oceanodroma hornbyi*) is endemic to the Humboldt Current. Historically, little has been known about the location of the species' breeding sites or the size of its population. For these reasons, this species has been classified as "Data Deficient" by IUCN, which makes it difficult to know whether the species is threatened, and if so, what conservation actions may be necessary. The project "Golondrinas del Desierto" began searching for the colonies of this species in November 2013. As a first step, we knew that the species breeds in the Atacama Desert, because some mummified individuals have been found there, and fledglings attracted by lights were falling out on their way to the sea. In this work, we present the first breeding site discovered for this species. This colony is 75 kilometers from the shoreline, at 1,100 meters above sea level, in the absolute desert. However, there exists a strong anthropogenic pressure in this area to develop mines and energy projects. For this reason, it is important to estimate the breeding population size of the colony, search for new colonies, assess the threats to each of them, and evaluate how many fledglings are drawn off course by lights into cities and industrial sites, and how many die there, for doing the correspondent management measures.

## SCALING-UP SEABIRD CONSERVATION IN MEXICO THROUGH A COMPREHENSIVE APPROACH

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Mexico has a strong responsibility for global seabird conservation since its islands are key breeding and resting sites for one third of all known seabird species worldwide. During the past two decades we focused our restoration efforts on removing the main threat to seabirds on their main island colonies. Therefore, to date we have eradicated 60 populations of invasive mammals from 38 priority islands, with benefits to over 250 seabird breeding colonies. To advance with conservation need for seabirds in Mexico, for the last decade we have been implementing a National Seabird Restoration Program, which includes: social attraction techniques; removal of introduced vegetation; environmental learning with local fishing cooperatives and communities; and a biosecurity program. We are currently working with 31 seabird species on 25 islands, focusing in northwest Mexico: Baja California Pacific, Gulf of California, and the Revillagigedo Archipelago. We have attended a vast knowledge gap generating scientific and base-line information, essential for conservation management. Our research is giving us valuable information on: population size,

nesting colonies distribution, productivity, genetic relationships, foraging and diet, and distribution at-sea. From our experience, we foresee the following priority actions: (1) agree upon, adopt and implement the recently formulated Action Plan for Seabirds in the Mexican Pacific in coordination with CONANP; (2) identify Marine Important Bird Areas with CONABIO, Pronatura, A.C., and BirdLife International; (3) assess current and potential threats at-sea; and (4) evaluate climate change related impacts to seabirds and their habitats.



## BREEDING IN AN UNPREDICTABLE ENVIRONMENT: EFFECTS OF FORAGING NICHE BREADTH ON BREEDING PHENOLOGY

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The timing of breeding is an important part of the natural history of an organism. For organisms whose offspring go through a period of dependency, it is vital that this period overlaps with the time of the year when resources are most plentiful. Depending on the variety of resources used, a species may be under intense selection to breed at the peak abundance of one particularly favorable prey species (a specialist), or may afford a greater variation because of its ability to exploit variable resources (a generalist). Based on where a species falls on the generalist/specialist spectrum, selection may operate differently on variability between and within years. I hypothesize that seabirds that fall closer to the generalist end of the spectrum will have greater variability in breeding timing within years, but between year variability will be relatively constant. For species closer to the specialist end of the spectrum, I hypothesize that there will be little variability within years, but between year variability will be greater, as breeding may need to track a peak abundance in prey that may vary from year to year.

## HISTORIAN SEABIRD BIOLOGIST EXTRAORDINAIRE: HARRY CARTER'S LEGACY AND HIS CONTRIBUTIONS TO DOCUMENTING AND ESTIMATING OIL SPILL IMPACTS ON SEABIRD POPULATIONS IN CENTRAL CALIFORNIA

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Harry Carter's passion for both seabirds and history made him unique in the field of seabird conservation. He delved deeply into historical accounts and combined current information to develop a realistic picture of the present. It was this characteristic that made Harry a tremendous asset to the seabird community in general. In addition, Harry took a keen interest in documenting oil spill impacts on seabird populations, with numerous publications on this topic, including his 2003 summary paper, "Oiled Seabirds in California: An Overview" (*Mar. Ornith.* 31: 1-7). This talk will summarize some of the influential work and contributions to this field, including: (1) documenting chronic and catastrophic oiling on seabird debilitation and mortality; (2) assessing injury due to oiling, including models on how best to extrapolate and estimate total seabird damage based on a subset of seabirds; and (3) summarizing past oiling events, their consequences, and protective legislation. Harry Carter's legacy and tremendous contribution to the field of oil spill injury provides a vision of just how far contingency planning has come and highlights some of the work that remains to further protect seabirds and their habitats.

## CARRION AND LARGE-BILLED CROWS PREDATE JAPANESE MURRELETS ON BIROJIMA

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Birojima is the largest known breeding site of the Japanese Murrelet (*Synthliboramphus wumizusume*). We recently found that many murrelet adults and eggs were preyed upon by 2 corvid species, the Carrion Crow (*Corvus corone*) and Large-billed Crow (*C. macrorhynchos*). The purpose of this study was to quantify the predation of murrelets by crows. We set out 2 motion sensing cameras to assess the diet of crows on the northwest side of Birojima. The cameras were set 30m from the coastline along the forest edge and used from 9 April 2016 to 3 March 2017. Cameras recorded 7,224 photos of 9 species of birds, including 1,529 photos of Carrion Crows and 10 of Large-billed Crows. We recorded 72 instances of foraging by Carrion Crows, including crows preying on adult Japanese Murrelets (7 cases), Japanese Murrelet eggs (3 cases), other birds (2 instances), fish (7), crustaceans (6) and others (48). All depredated adult murrelets were taken in April. In contrast, only murrelet eggs were taken in May and June. As for the Large-billed Crow, there is only 1 confirmed case of foraging a Japanese Murrelet egg on mid-July. It is known that 1-3 pairs of crows breed every year. Two nest of the Large-billed Crow has confirmed in 2016. There are still no record of the Carrion Crow breeding at Birojima, but our camera data of Carrion Crow families indicate the possible breeding of them at Birojima. Our study shows that 1 pair of crows can have significant impacts on murrelets.

PREVALENCE AND STATUS OF AVIAN POX VIRUS AND IMPLICATIONS FOR WEDGE-TAILED SHEARWATER (*ARDENNA PACIFICA*) COLONIES IN MAUI NUI

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Distribution of avian pox virus (*Poxvirus avium*) is well documented in a variety of bird species including songbirds, gamebirds, raptors and Hawaiian forest birds. While the virus occurs at varying degrees dependent on the affected species, characterization of different strains has found some poxviruses to be species specific. Little is known about the dispersal and effect of avian pox in Wedge-tailed shearwaters ('Ua'u kani; *Ardenna pacifica*), a tropical and sub-tropical seabird species. Since 1996, the Maui Nui Seabird Recovery Project has tracked the occurrence and biology of known 'Ua'u kani colonies within Maui Nui (islands of Lāna'i, Molokai, Kaho'olawe, and Maui). Visual inspections of each bird handled during fallout, banding, and burrow monitoring events have produced a long-term record of pox prevalence. In this study, we use historical data to report the status of this mosquito-borne disease at known colony sites. Using monthly and annual rainfall summaries from local stations observed by various partner affiliations, we predict a positive correlation between mean precipitation rates and incidence of pox for each site over time. Patterns of incidence were mapped, attributing burrow density to the distribution of the virus. Additional monitoring of colony environmental factors will reveal patterns of vector magnitude and pox distribution in Wedge-tailed shearwater colonies. Implications of predicted climate changes (e.g., increased rainfall and sea level rise) will have an effect on shearwater habitat, and may increase vector populations and virulence of known poxviruses.

ANNUAL VARIATION OF THE BROWN BOOBY TROPHIC ECOLOGY (*SULA LEUCOGASTER*), IN PEÑA BLANCA ISLAND, COLIMA, MEXICO.

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Peña Blanca, Colima, Mexico is a small rocky island 2 km away from the coast, with an area of 11 hectares, located west of Manzanillo Port. It shelters the biggest reproductive colony of the Brown Booby (*Sula leucogaster*) confirmed in the Mexican South Pacific. Adult species' diets were analyzed by collecting regurgitates for three months in each of three years (July, August and September of 2014, 2015 and 2016) in male and female specimens. To determine prey importance in the diet, the percentage of the prey-specific index of relative importance (%PSIRI) was used and an analysis of similarity was made; in addition, AQUA-MODIS satellite images were used to obtain superficial sea temperature and chlorophyll-*a*. The composition of the diet was different between genders and ages. The similarity analysis and multi-dimensional scaling (MDS) indicate the separation of two groups ( $P < 0.05$ ,  $F = 4.6$ ), one formed by females and males from 2014 and 2015 and another formed females and males from 2016. The presence of the phenomenon El Niño in 2015-16, considered one of the most intense yet, could explain the presence of Dolphinfish (*Coryphaena hippurus*) during warm conditions; this species had not been registered as part of the Brown Booby diet in previous studies of the Mexican Pacific.

## MURRELET MADNESS: HARRY CARTER'S LEGACY WITH MARBLED, SCRIPPS'S AND GUADALUPE MURRELETS

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Harry Carter was a tour de force in the seabird world, especially related to his research and conservation of Pacific auks. In the early 1980s, Harry began his master's research on the at-sea biology of Marbled Murrelets (*Brachyramphus marmoratus*) in British Columbia, under the tutelage of Dr. Spencer Sealy, and continued his investigations into their ecology until his death in 2017. Two seminal papers on this species included his study of murrelet mortality due to oiling and mortality in gill-nets, the first study looking at the impacts of gill-nets on seabirds. Equally significant was his interest in the conservation of murrelet nesting habitat and synthesis of historic information on Marbled Murrelets throughout their range. In addition, he helped shepherd the Pacific Seabird Group's Marbled Murrelet Technical Committee on conservation issues and had a profound impact on the focus of the research of many murrelet scientists. In 1991, Harry began studying *Synthliboramphus* murrelets in the Channel Islands of southern California and islands off western Baja, Mexico where he helped develop innovative survey and capture techniques, providing a better understanding of their range-wide distribution, abundance, and nesting habitat. During 27 years of *Synthliboramphus* research, his efforts were instrumental in listing Scripps's Murrelet (*S. scrippsi*) as a threatened species in California, recognition of Scripps's and Guadalupe (*S. hypoleucus*) murrelets as distinct species, and documenting the recovery of Scripps's Murrelets following eradication of rats at Anacapa Island. Harry's legacy will live on in the seabird biologists around the world that he encouraged and mentored, and his many publications on murrelets, auks and conservation.

## CLIMATE CHANGE, HABITAT LOSS, AND PREDATORS AFFECT THE RECENT DISTRIBUTION OF MARBLED MURRELETS IN THE PACIFIC NORTHWEST

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The Marbled Murrelet (*Brachyramphus marmoratus*) has declined across much of its range and currently is listed as threatened in the conterminous United States under the Endangered Species Act. Although loss of nesting habitat loss is considered the primary driver of murrelet declines, low recruitment due to nest predation, particularly by corvids, is also suspected to be a major driver. Further, climate change has the potential to alter distribution and abundance patterns of both murrelets and their nest predators, thereby increasing the susceptibility of murrelet nests to predation. Understanding the relative influence of climate, land cover, and predator distribution and abundance on the distribution of Marbled Murrelets is thus a critical information need for effective restoration. We modeled the abundance and distribution of corvids known or suspected to prey upon murrelet nests (Steller's Jay [*Cyanocitta stelleri*], Common Raven [*Corvus corax*], American Crow [*Corvus brachyrhynchos*], and Gray Jay [*Perisoreus canadensis*]) over a 30-yr period across the range of murrelets in California, Oregon, and Washington. We combined the resulting predictions from these models with annual measures of mature forest and climate in a dynamic occupancy framework to assess how these factors could influence local colonization and extinction of the murrelet. Our results can be used to better identify management options for recovering the Marbled Murrelet in the Pacific Northwest.

## HABITAT RESTORATION IMPROVES NESTING HABITAT FOR BROWN BOOBIES (*SULA LEUCOGASTER*) ON KURE ATOLL

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Kure Atoll, within Papahānaumokuākea Marine National Monument, provides critical breeding habitat for 18 species of seabirds. Non-native plant introductions starting in the 1950s decreased the availability of suitable nesting habitat for many of the island's ground-nesting seabirds. Teams from the State of Hawaii have been targeting non-native species for eradication seasonally since 1993, and year-round starting in 2010. In 2014 treatment of the entire 188 acres of vegetated area on the atoll was accomplished, and has since been maintained. The top priority plant for eradication is the prolific annual *Verbesina encelioides*, which grew in widespread monotypic stands. These stands caused heat stress and habitat loss, among other issues, in ground-nesting seabirds. Intensive habitat restoration efforts have eliminated the dense stands of *V. encelioides* from the atoll and spurred a resurgence of low-lying native ground cover. Year-round restoration effort and the removal of *V. encelioides* has not only enhanced breeding habitat, but has also promoted more effective monitoring for several ground-nesting seabirds, including brown boobies (*Sula leucogaster*). Censuses of brown boobies from 2014 to 2017 have shown dispersal into areas that were previously dominated by monotypic *V. encelioides* stands, and a 19% increase in fledglings. Continued efforts to eradicate *V. encelioides* will facilitate further improvements in seabird habitat and encourage recruitment of ground-nesting seabirds into newly accessible breeding areas.



## PREDICTING BYCATCH FOR BLACK-FOOTED AND LAYSAN ALBATROSSES BY JAPANESE LONGLINE FISHERIES WITH SPATIO-TEMPORAL OCEANOGRAPHIC FACTORS.

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Bycatch of albatross species by pelagic longline fisheries is one of the causes inducing mortality of those species. For conservation of threatened albatross species, it is essential to estimate the impact of bycatch on their populations. In this study, we modeled monthly bycatch rate for black-footed and Laysan albatrosses (*Phoebastria immutabilis*) by 1x1 grid in latitude and longitude using oceanographic variables such as SST and oceanic primary productivity. The bycatch data were collected through the Japan scientific observer program on pelagic longline fishery operated in the western north Pacific during 2014-2016. Spatio-temporal distributions of bycatch rate in both species were finally predicted using the seasonal oceanographic data during 2014-2016. Bycatch rate in black-footed albatrosses was the highest during February-March and the lowest in September and higher SST (range:15-30°C) tended to increase bycatch rate of this species. Bycatch rate of Laysan albatrosses was the highest during December-January and the lowest in September and higher bycatch rates were found around 18°C and 23°C. Higher bycatch rate of Laysan albatrosses was also found at specific oceanographic productivity ( $e^6 - e^{6.9}$  mgC/m<sup>2</sup>/day). Predicted spatio-temporal distributions of bycatch rate showed that black-footed albatrosses had higher rate in the subtropical area in the center of the north Pacific during winter-spring and in the further north area, eastern end of the Kuroshio extension during summer-autumn and that Laysan albatrosses had higher bycatch rate around Kuroshio extension through all season. The difference of bycatch rate among both species may be reflecting preference of target prey species for both species.

## SEASONAL VARIABILITY IN VULNERABILITY FOR CASSIN'S AUKLETS EXPOSED TO PLASTIC POLLUTION IN THE CANADIAN PACIFIC REGION

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Marine plastic pollution is an emerging global conservation challenge, impacting organisms at all trophic levels. Clarifying interactions between marine birds and plastic pollution is important for understanding and estimating impacts. Exposure to plastic pollution can vary seasonally and timing of exposure to elevated concentrations can interact with critical periods in the annual cycle. For example, plastic consumption may affect bird survival during migration or over the winter when survival is typically more challenging. In this paper we explore seasonal exposure of Cassin's Auklet (*Ptychoramphus aleuticus*; CAAU) to plastic pollution with an exposure models during the breeding and non-breeding seasons, and infer exposure during the winter based on necropsy results from carcasses collected during a large mortality event in 2014. The exposure models quantify plastic exposure by determining seasonal core foraging areas and plastic concentrations found in those areas. Core foraging areas were determined using a Generalized Additive Model (GAM) based on at-sea observation data (breeding: May-September; non-breeding: October-May – 1990-2010) and 50% Home Range Kernels based on telemetry data (May, June 1999-2001). Plastic concentrations within these core areas were interpolated based on samples taken during late summer 2012. We found breeding CAAU were exposed to low concentrations of plastics when they are probably exploiting upwelling features. These results were consistent with results from a study recently

published based on chick provisioning. On the other hand, 41% of necropsied CAAU had consumed plastic indicating that they are exposed to increased concentrations when upwelling ceases and/or they are targeting plastic as food during the winter.

## REPRODUCTIVE BIOLOGY OF *STERNULA LORATA* IN MEJILLONES, CHILE

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The Peruvian tern (*Sternula lorata*) is a migratory bird, that nests in the Atacama Desert, from Ecuador to northern Chile (Antofagasta region). According to UICN, they endangered (EN), mainly due to population reduction resulting from the impact of human activities in their nesting sites. During past 9 years we monitored and studied their reproductive biology at six nesting sites in the Antofagasta region near Mejillones. The Peruvian terns arrive here in the austral winter in June or July and depart in the austral summer in December or January. Within this coastal plain between 22°42' and 23° 30' south latitude, we documented nest distribution, distance between nests, clutch size, timing and length of incubation, growth rates of chicks, and chick provisioning.

## COMPARING IMAGING, ACOUSTICS, AND RADAR TO MONITOR LEACH'S STORM-PETREL COLONIES

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Effective monitoring of seabird populations is important, as seabirds are highly threatened, and valuable indicators of marine ecosystems. Many seabird species nest in burrows, which are often infeasible or costly to monitor using traditional methods. In Oregon, there have been large declines in Leach's Storm-Petrels (*Oceanodroma leucorhoa*) at certain colonies, while population trends at other colonies appear to be relatively stable. Traditional burrow occupancy surveys are unable to capture the timing of declines and provide an incomplete understanding of population trends. Here we compare three methods of remote monitoring - time-lapse cameras, acoustic recorders, and radar surveys - to traditional burrow occupancy surveys for Leach's storm petrels. We included a high density (4.66 occupied burrows/m<sup>2</sup>) and a low density (0.045/m<sup>2</sup>) nesting island. We use daily, seasonal, and annual changes in abundances to test the sensitivity of each method to detect changes in abundance and correlation with burrow occupancy. Nightly acoustic data were quantified through detection of two calls using Deep Neural Network algorithms: an aerial call and a ground call, and a metric of relative acoustic energy. Image counts were conducted manually. In general, we found significant linear trends between radar abundance, image counts, and aerial calls ( $R^2=0.31-0.79$ ). Ground call rates significantly correlated with burrow occupancy ( $R^2=0.69$ ,  $p=0.01$ ), but were not strongly correlated with other methods. Acoustic monitoring appears to have

the greatest potential for large scale monitoring efforts, however image counts may be comparable with standard methods (e.g. radar) in producing annual indices, and are also useful for monitoring predator activity.

FOR TWENTY-THREE YEARS OF HARRY CARTER'S INVALUABLE CARING, AND HELP WITH LOGISTICS ON BEHALF OF THE JAPANESE MURRELET MONITORING PROJECT IN JAPAN

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Harry was very fond of Japan. He always helped to develop better PSG ties with Japanese biologists, and to initiate joint conservation efforts in Japan. Since his first trip to Japan in 1993, he was involved in 18 projects in Japan. I've never seen such a crazy passionate man who spent so much energy for the other end of the Pacific Ocean. His early visits to Japan in 1993 might have been due to his curiosity about the Japanese Murrelet (JAMU: *Synthliboramphus wumizusume*). Once he started his project in Japan, he soon learned that a monitoring system for JAMU was needed there, and it became his long-term goal to achieve this. It is common to have extra interests while working on one issue. His 18 projects included several issues related to JAMU: establishing the monitoring system, educating people, recovery from an oil spill, and a proposed nuclear power plant. People who worked with Harry have been inspired by him deeply, and there has been much improvement in each project Harry related since 1993. Despite numerous successes, he always focused on establishing a monitoring protocol for the JAMU. A symposium on the species was held in Kadogawa, Miyazaki Prefecture, Japan in 2017. This whole symposium was designed around establishing a monitoring protocol. After the symposium, he was pleased to hear the success of it, although details of the monitoring protocol were not finalized. A committee has been established to continue work on the protocol, and to carry on Harry's legacy.

## ESTIMATED IMPACT OF CROW PREATION ON JAPANESE MURRELET ON BIRO ISLAND, MIYAZAKI PREFECTURE, JAPAN

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The Marine Bird Restoration Group has been conducting nest monitoring for the Japanese Murrelet (*Synthliboramphus wumizusumi*) at Biro Island, Miyazaki Prefecture, Japan. This monitoring method was introduced by H. Carter and D. Whitworth in 2013. Many murrelet carcasses have been found on Biro Island, but there have been no predator surveys there. It is important to consider impacts of predation among the protection measures for this endangered species. We conducted predator surveys, collecting murrelet carcasses and finding nests of potential predators, in 2016 and 2017. We also summarize records of crows at Biro Island from existing reports. We confirmed that major predators on murrelets at Biro Island are Large-billed Crows (*Corvus macrorhynchos*) and Carrion Crows (*C. corone*). Four nest sites of crows were confirmed; two nests were usually found on the island in a given year, but there may have been three in one year. Many murrelet carcasses were recorded in the crows' nesting habitats. The crows bring murrelets close to their nests, then reduce the corpses to small pieces for feeding. We estimated that 30-50 adult murrelets may be killed by one pair of nesting crows per year. In total, about 60-150 murrelets appear to be killed each year by crows there. Relatively high numbers of murrelets seem to be killed by a few crows there. During nest monitoring, we also observed that eggs disappeared from murrelet nests. We suspect that those losses were also due to crows, because there was nothing left in the nests.



## CURRENT POPULATION STATUS OF THE CALIFORNIA LEAST TERN IN MEXICO

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The California Least Tern (*Sternula antillarum browni*) is a small seabird listed in the United States and Mexico. It breeds from San Francisco, California USA to Bahía Magdalena, Baja California Sur, México. The population segment in California has been intensely monitored and managed, but not in Mexico. We need to assess the risks faced by this subspecies in Mexico to understand the dynamics and vulnerability of the population as a whole. In 2003 only 11 colonies, out of 25 known colonies, were active. The total breeding population was estimated at 340 breeding pairs. In 2017, we found only 155 breeding pairs along the Pacific coast of the peninsula. Only seven colonies, were used in 2007; six nesting sites at Guerrero Negro and one at Bahía Magdalena were not active at the time of our survey in June; and 11 historical nesting sites have not been active for the last several years and can be considered extirpated. The causes for nesting site abandonment are either natural changes due to storms that affect the coastline (six sites), or because of human disturbance, establishment of trailer parks, housing development, or heavy human use (five sites). Current population of this subspecies in Mexico is estimated at no more than 400 pairs nesting in 11 colonies. We provide baseline data on its breeding population status against which future works can be compared.

## GOING ONCE, GOING TWICE...GONE? CALIFORNIA'S LARGEST LEACH'S AND FORK-TAILED STORM-PETREL COLONIES ON THE BRINK OF EXTIRPATION?

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In September 2012, we assessed the status of burrow-nesting seabirds at breeding colonies in the California Coastal National Monument, near Trinidad (Humboldt County), California. We visited three coastal rocks where Leach's and fork-tailed storm-petrel (*Oceanodroma leucorhoa*, *O. furcata*) colonies were last surveyed in 1989. The overall number of storm-petrel burrows declined from 4,195 in 1989 to 222 in 2012. Based on burrow counts, the colony at Prisoner Rock had been extirpated while colonies declined 94.6% at Little River Rock and 90.5% at Button Rock. Depredation by northern river otter (*Lontra canadensis*) and American mink (*Neovison vison*) has been suggested as a possible factor in these declines. The decline and possible extirpation of storm-petrel populations at these three rocks has important regional implications as these colonies accounted for 66% and 76% of the Leach's and fork-tailed storm-petrel populations, respectively, in California. We believe studies are warranted to: 1) better assess the status of these populations and determine cause(s) of the decline; and 2) develop management actions to protect and recover these populations before extirpation occurs at all colonies within the Trinidad area.

## FORAGING BEHAVIOR OF THICK-BILLED MURRES BREEDING IN THE CANADIAN ARCTIC

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Intraspecific competition at large seabird colonies increases energy costs for the parents, which is thought to limit colony size for many seabird species. We studied the foraging behaviour of thick-billed murres (*Uria lomovia*) from three colonies in the Canadian Arctic Coats Island (30 000 pairs), Cape Graham Moore (CGM; 50 000 pairs) and Digges Sound (400 000 pairs), collecting data from 450 birds over 10 colony years between 2010 and 2017. Foraging trips from Coats (4 hr duration and 19 km maximum distance) were shorter than CGM (7 hr and 29 km) and Digges (12 hr and 57 km). At Digges and Coats, there was up to a two-fold variation in trip duration and maximum foraging distance among years. However, only murres from Coats, the smallest colony, exhibited inter-annual variation in energetic rate (kJ/hr) and proportion of time flying. Across colonies, energetic rate reached an asymptote at 180 kJ/hr for longer trips (> 8 hrs. and >10 km), which we interpret as an energetic ceiling above which murres cannot increase foraging effort. These pronounced differences in foraging effort among colonies are indicative of density-dependent effects on foraging behaviour. Intraspecific competition is likely compounded by energetic constraints on foraging in murres, which limits their ability to increase foraging rates when prey are distant from the colony. There were also substantial annual differences in foraging behaviour within colonies, which likely reflect inter-annual environmental variability and play an important role in determining annual reproductive success at larger colonies.

## ESTIMATING POPULATION ABUNDANCE OF ANCIENT MURRELETS ON EAST LIMESTONE ISLAND, BC, USING N-MIXTURE MODELS

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The Ancient Murrelet (*Synthliboramphus antiquaas*) is a seabird that nests on forested islands throughout the Haida Gwaii archipelago in British Columbia, Canada. This genus of seabird is unusual because the chicks depart the underground burrow at only a few days old, which has led to the development of a unique monitoring method. Using plastic fences throughout the forest, chicks are directed to collection points where they can be counted. The Laskeek Bay Conservation Society (LBCS) has been using this monitoring method to collect count data for Ancient Murrelet chicks departing from one small colony, East Limestone Island, since 1990. This long-term dataset has provided information on the trend of breeding birds in a colony threatened by introduced Raccoons (*Procyon lotor*), and now more recently by storm events and windfall that have dramatically changed the breeding habitat in approximately half of the colony area. Along with yearly monitoring by LBCS, censuses have been conducted by the Canadian Wildlife Service approximately every 10 years, to estimate the total breeding population. Here, we describe an alternate method for estimating population size based on the chick count data over time, using N-mixture models. N-mixture models estimate population abundance with replicated counts through time. We will present preliminary results and discuss how this estimate can be used as an index for the breeding population size, and where this population index could be used to evaluate population trend. This methodology could potentially be applied to obtain breeding population size estimates for other seabird monitoring programs that use chick counts to estimate trends in total population.

ACOUSTIC MONITORING FOR SEABIRDS ON HALEAKALA, MAUI; CHANGE OVER TIME, 2014 – 2017

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Storrs Olsen and Helen James, in their 1982 Prodnomus of the Fossil Avifauna of the Hawaiian Islands, stated that *Pterodroma phaeopygia* (Now *P. sandwichensis*, Hawaiian petrel) were the most common fossil bones found in lava tubes. Their research established that Hawaiian petrels were likely the most numerous birds in the islands pre-human arrival. Habitat alteration and the introduction of alien mammals that predate ground nesting seabirds has resulted in this species population being reduced to where US Fish & Wildlife Service has listed it as endangered. As we work to restore habitat and reduce predator populations we have made extensive use of automated acoustic monitoring to document presence or absence and track population changes. Acoustic monitoring for the presence of seabirds in the Nakula Natural Area Reserve and Kahikinui Forest Reserve, Haleakala, Maui was performed at the same 15 locations in both 2014 and 2017. Ungulate fencing of the survey area was completed in July, 2014 and feral ungulates were removed shortly thereafter. Maui Nui Seabird Recovery Project staff began predator control for small mammals at the same time. There were just 8 active Hawaiian petrel burrows in 2014 and acoustic monitoring documented very few calls. In this presentation we document the changes which have occurred in the acoustic environment between 2014 and 2017. Activity at burrow sites increased to 32 active sites and acoustic recordings also increased across the restoration area. Evidence of on the ground increased petrel activity and next steps toward a healthy, increasing population will be described.

## A SEABIRD MONITORING PROGRAM FOR ONGOING AND PROSPECTIVE OFFSHORE ENERGY PROJECTS IN THE PACIFIC

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Offshore energy development, including oil and gas extraction and offshore wind turbines, poses potential threats to seabirds. Proper mitigation through oil spill response planning, infrastructure positioning, and lighting schemes can reduce this potential. A cost-effective monitoring program would enable scientists and managers to determine the effectiveness of mitigation strategies by (1) elucidating regional population trends of vulnerable species, and (2) estimating avian mortality rates from offshore energy operations. In combination, these two approaches can indicate when corrective management actions would be necessary. BOEM scientists' proposed a seabird species monitoring program using acoustic methods or other appropriate technology for ongoing or prospective offshore energy projects in California, Hawaii, Oregon, and Washington. The envisioned program would build upon and utilize other recent studies, including a *Marine Bird Vulnerability Index* and *Synopsis of Research Programs*, to identify species at risk and identify ongoing monitoring efforts that would be useful to coordinate over larger scales and supplement to meet this program's objectives. The goal is to distinguish population trend modifications resulting from offshore energy projects compared to other factors such as dynamic oceanographic conditions, degraded ocean productivity, or fisheries bycatch. A 3-year regional monitoring effort would refine baseline information and improve site-specific estimates of species diversity and density for monitoring and estimating avian mortality from offshore energy operations.

## A SUMMARY OF ALBATROSS BAND RECOVERY DATA IN THE HAWAII DEEP AND SHALLOW SET LONGLINE FISHERIES

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This project is a summary of Hawaii Longline Fisheries observer program seabird band recovery data that has been accrued during the January 01, 2002 through December 31, 2016 period. The National Marine Fisheries Service Pacific Island Regional Office Fisheries Observer Program has been deploying observers on board Hawaii-permitted longline fishing vessels, as part of a mandatory requirement, since February of 1994. Seabirds, most commonly the Black-footed and Laysan Albatross species, are known to occasionally interact with the observed longline fisheries. As a part of their regular responsibilities, observers deployed on longline fishing vessels record seabird sightings, document any observed fisheries interactions, assist with handling hooked or entangled seabirds, salvage dead seabirds, and report on compliance with all existing fisheries-related regulations (many of which are aimed at mitigating seabird interactions). Observers also opportunistically record seabird band recovery data. All banding-related data are maintained in an 'in-house' database, and are also submitted to the United States Geological Survey, Patuxent Bird Banding Laboratory (BBL) where they are joined with existing banding data provided by the United States Fish and Wildlife Service and others into a centralized bird banding laboratory database. The results presented here represent a cooperative effort between the NMFS, USFWS, USGS, as well as other governmental and non-governmental agencies.

## A SUMMARY OF SEABIRD INTERACTIONS IN THE HAWAII DEEP AND SHALLOW SET LONGLINE FISHERIES IN 2016

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The National Marine Fisheries Service (NMFS) Pacific Islands Regional Office (PIRO) observer program has been monitoring the catch of the Hawaii pelagic longline fisheries under mandate since 1994. During this time, NMFS observers have documented seabird interactions (hookings or entanglements) with the following species: black-footed albatross (*Phoebastria nigripes*), Laysan albatross (*Phoebastria immutabilis*), sooty shearwaters (*Puffinus griseus*), unidentified shearwater species (*Puffinus spp.*), brown boobies (*Sula leucogaster*), red-footed boobies (*S. sula*), and northern fulmars (*Fulmarus glacialis*). The deep set fishery has been monitored under mandatory 20% observer coverage since 2000, and the shallow set fishery has been monitored at 100% coverage since 2004. Seabird-specific mitigation measures implemented by 2004 significantly reduced interaction rates in both fisheries (91%/Shallow Set; 74%/Deep Set). Total seabird interactions have remained relatively consistent from 2015 to 2016 (213 to 207). The interaction rate (birds/1000hooks) for the deep set fishery (0.014) has remained higher than the 10-year mean (0.008) for the past 2 years. As has consistently been the case, most (96%) of the seabirds in the deep set fishery were caught dead, and most (77%) of the seabirds in the shallow set fishery were caught and released alive in 2016.



## CONTROL OF MULTIPLE RODENT SPECIES AROUND ENDANGERED SEABIRD COLONIES ON THE ISLAND OF KAUA'I

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Hono O Nā Pali Natural Area Reserve is an important breeding site for the federally threatened Newell's Shearwater (*Puffinus newelli*), the federally endangered Hawaiian Petrel (*Pterodroma sandwichensis*) and the Band-rumped Storm-Petrel (*Oceanodroma castro*). Breeding colonies of these seabirds elsewhere on the island of Kaua'i face threats from anthropogenic sources such as light pollution and power line strikes. While the colonies in Hono O Nā Pali are relatively unaffected by such threats given the lack of human habitation and infrastructure on the northwest coast of the island, they do face predation from a variety of invasive mammals including several rodent species (*Rattus rattus*, *Rattus exulans*, *Rattus Norvegicus*, and *Mus domesticus*). Given the open nature of the reserve and political and community considerations, rodent control in the area is accomplished solely through the use of mechanical traps. Rodents are primarily removed through a combination of Goodnature A-24 automatic traps, Tomahawk live cage traps, and Victor snap traps. Rodent presence is monitored throughout the year using game cameras. Our data indicates that Goodnature A-24's are the most efficient trap type and are effective in suppressing rodent populations and associated with an increase in seabird fecundity. However, our data also show that the rat species community differs throughout the reserve and that each trap type targets a different segment of the rodent community. In situations where multiple rodent species are present, it is important to use a diversity of trapping methods to ensure that all species are being suppressed and breeding birds are being adequately protected.

## OLFACTORY FORAGING IN A CHANGING ENVIRONMENT

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Understanding how animals locate food in dynamic environments is critical to predicting their capacity to respond to environmental change. However, studies of predator foraging have typically focused on where species forage rather than their strategies for navigating through a changing environment to locate prey. Although appearing visually featureless, the open ocean is overlaid with an olfactory landscape that may highlight areas of productivity. Dimethyl sulphide (DMS) and ammonia may be important cues for predators when locating foraging areas. DMS concentration is enhanced in areas where phytoplankton is grazed by zooplankton, and can indirectly signal to predators the presence of prey aggregations. Similarly, elevated ammonia levels result from the nitrogenous wastes of both zooplankton and other predators. In southeast Australia, little penguins (*Eudyptula minor*) breed in an area facing three times the average global ocean warming rate, due to strengthening of the East Australian Current. Changes to seawater temperature in this region may impact phytoplankton growth, potentially altering both prey species abundance and distribution, and may alter olfactory cue production. We investigated the role of olfactory foraging cues in little penguins. We found that little penguins are sensitive to DMS and ammonia, suggesting that both may play a role in foraging. We discuss the ability of marine predators such as little penguins to respond to changing levels of olfactory foraging cues in the marine environment, and their vulnerabilities to predicted alteration of cue production and distribution associated with climate change.

PATHOGEN SURVEILLANCE IN BLACK-VENTED SHEARWATER NESTING ON NATIVIDAD ISLAND,  
BAJA CALIFORNIA SUR, MEXICO.

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The Black-vented Shearwater (*Puffinus opisthomelas*) is a Mexican endemic seabird. Approximately 95% of the world's population breed on Natividad Island, Baja California Sur. Currently *P. opisthomelas* is classified as Near Threatened by the IUCN and Endangered by the NOM 059. In the past, *P. opisthomelas* has been in contact with introduced fauna that can act potentially as diseases vectors, including cats. Other factors that may contribute to the species exposure to zoonotic and other emerging pathogens are the specie's limited geographic distribution, migratory birds and human contact, and solid unmanaged waste produced in the island. In this study, we investigated pathogen exposure in the host population of *P. opisthomelas* inhabiting Natividad Island to evaluate the specie's vulnerability to infectious disease-related extinction risk.

Faecal and blood samples from 30 individuals of *P. opisthomelas* were collected *in situ* during spring 2017. Genomic DNA was isolated from the corresponding samples and analyzed using molecular technique Polymerase Chain Reaction (PCR) to verify the presence or absence of five zoonotic and/or emerging pathogens including *Chlamydophyla psittaci*, *Mycobacterium avium*, *Toxoplasma gondii*, *Salmonella spp.* and *Avipoxvirus*. Our results will provide a preliminary information about the health status and disease-related extinction risk of the Black-vented Shearwater population of Natividad Island.

PREDICTING CALIFORNIA LEAST TERN (*STERNULA ANTILLARUM BROWNI*) CHICK SURVIVAL  
USING GROWTH RATES AND PARENTAL ATTENDANCE

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Estimating yearly chick survival is a key component to understanding the overall population status of breeding seabird species. Such estimates are difficult to obtain in species with highly mobile chicks, such as the California Least Tern (*Sternula antillarum browni*), which disperse soon after hatching. Methods such as radio telemetry to track older chicks and visual counts of fledglings have been used to generate fledgling rates, both with inherent error. Chick growth rates are easily quantifiable, thus may be a reliable indicator of colony-wide trends. Using data collected from two major California Least Tern colonies in San Diego County from 2014 to 2017, we investigate whether chick growth patterns are a consistent predictor of survival to fledge age. In addition, we review other factors, such as parental attendance and general trends in the marine environment in California, which may influence productivity. Discovering early predictors of chick survival may allow for less intensive monitoring, and thus less disturbance to this sensitive recovering species.

## HOMEWARD BOUND – TRACKING ENDANGERED SEABIRDS ON KAUAI

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On Kaua'i, Newell's Shearwaters (*Puffinus newelli*) and Hawaiian Petrels (*Pterodroma sandwichensis*) breed in remote breeding colonies, predominantly in the mountains of the north-west of the island. Understanding the flight paths of birds at these colonies is a vital component for assessing how they interact with power lines and how they are affected by light attraction – two key threats to seabirds on Kaua'i. In 2016 and 2017, we attached data loggers to breeding birds at burrows in Upper Limahuli Preserve and Hono o Na Pali. For Newell's Shearwater, birds on outbound tracks fanned out in all directions, flying high out to sea and gradually descending until they reached sea level several kilometres offshore. The pattern was very different on inbound flights; almost all birds flew low along a single ridgeline, indicating that birds use a combination of terrain and prevailing winds during return flight paths. Although Hawaiian Petrel outbound and inbound tracks were more dispersed, there were several key routes used by individuals returning to colonies. Several birds flew over power line spans, in some cases, at or near line height. We consider the challenges of undertaking this study and discuss different attachment methods and available data logger technologies. We also consider our next step – catching seabirds at key powerline collision hot spots away from breeding colonies. Obtaining data quantifying key flight routes and flight heights is critical for understanding the efficacy of certain adaptive management measures urgently required to minimize powerline strikes, including lowering power lines and re-routing power line paths.

## AERIAL ROOSTING NEAR TERRESTRIAL ROOSTS IN MAGNIFICENT FRIGATEBIRDS

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Frigatebirds are tropical seabirds renowned for their ability to soar over the ocean and forage without landing on the water. Great frigatebirds (*Fregata minor*) engage in non-stop pelagic flights lasting two months and can even sleep while soaring at night (Rattenborg et al. *Nature Communications*, 2016). However, the amount and quality of sleep in flight is greatly reduced when compared to sleep on land. Consequently, frigatebirds inhabiting coastal waters, such as magnificent frigatebirds (*Fregata magnificens*), should maximize the benefits of sleep and conserve energy by landing every night. We used GPS to characterize the nocturnal movements and roost site selection of magnificent frigatebirds around Baja California, Mexico. As expected, the birds often spent several hours at night perched on small islands or mangroves along the coast. However, on many nights they remained on the wing. Unlike frigatebirds nesting on oceanic islands, nocturnal flight was rarely related to multiday foraging trips far from land. Instead, the birds appeared to soar on air currents deflected upward by land masses. Paradoxically, these land masses included the small islands upon which the birds landed to roost on other nights. The reasons why frigatebirds did not always land when close to suitable terrestrial roost sites remain unclear, but likely reflect several interrelated factors including wind conditions, the relative costs and benefits of landing versus staying on the wing, as well as the bird's energetic status and sleep deficit.

## BRIDGE TO THE 21<sup>ST</sup> CENTURY AND CORMORANTS ARE ON IT

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Colony creation, especially in built environments, will become a critical tool for seabird conservation as sea levels rise. Lessons learned, from designing novel habitat to adoption over a 16-year period, are presented. The San Francisco Bay population of Double-crested Cormorants (*Phalacrocorax auritus*) formed a colony on the iron beams under the eastern span of San Francisco-Oakland Bay Bridge in the 1980s. Seismic damage after the 1989 earthquake prompted the need for a safer bridge made of cement. In 2001, the California Department of Transportation commissioned my design for 7,200 square feet of replacement habitat for the cormorants. By 2011, the stainless steel platforms, referred to as “Corm Condos,” were erected and accessible to the birds. Although social attraction techniques were implemented for six years, no cormorants were ever seen to use the platforms. Only until the final section of the old bridge was removed in March 2017, did the birds show interest. On April 2, the first two cormorants were observed using the roosting rails of the new platforms. By April 24, about 500 were counted. The first egg was seen in May, and on June 9, at least 318 nests were made in this first year. Social attraction may have made the new platforms appear safe, but until the old site was no longer available did the colony relocate. Implications for creating new colonies will be discussed.

## THE SWIMMING SPEED-THRUST RELATIONSHIP IN FOOT-PROPELLED DIVING BIRDS AND ITS ENERGETIC AND BEHAVIORAL IMPLICATIONS

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To swim underwater, foot-propelled avian divers use paddling with webbed feet to push the body forward against water (i.e., to generate hydrodynamic thrust). Foot propulsion has been traditionally considered to be a form of drag-based swimming. However, studies on fast swimming pursuit divers, such as cormorants and grebes, showed that the motion of the feet during the power stroke generates hydrodynamic lift forces in the direction of swimming, contributing significantly to propelling the bird underwater. The ability to generate lift forces with webbed feet makes propulsion more energetically efficient and allows for faster swimming speeds. However, the ability to use paddling feet for lift-based propulsion is a direct result of the high swimming speed of the bird. Therefore, the relationship between thrust, swimming speed and propulsion efficiency is complex and unclear, and it is unclear how webbed feet transition from drag- to lift-based swimming at lower swimming speeds. Here, I use data from submerged swimming in cormorants (Phalacrocoracidae) to construct a biomechanical model of the paddling at various swimming speeds and swimming directions (horizontal swimming, vertical descent to the bottom and descent at acute angles). The model is based on the hydrodynamics of the moving feet and predicts the acceleration of the body (surge and heave) and the energetic efficiency of paddling at different swimming speeds. The predictions from the model can provide a link between data derived from accelerometers mounted on wild diving birds and the swimming speed and energetics of the birds.



## SIMILAR, BUT DIFFERENT: RELIANCE ON MARINE RESOURCES BY SYMPATRICALLY BREEDING RED-THROATED AND PACIFIC LOONS IN THE ARCTIC

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Red-throated (*Gavia stellata*) and Pacific (*G. pacifica*) loons breed sympatrically, but differ in their use of marine resources. Red-throated Loons rely exclusively on marine fishes, while Pacific Loons use both freshwater and marine prey. We examined the consequences of resource partitioning on diet, body condition, and productivity in loons breeding in Alaska. Stable isotopes and fatty acids indicated that Pacific Loon diet was composed of a mix of freshwater and marine prey. The amount of marine prey in their diet decreased with lake size, suggesting that small lakes were not profitable foraging habitat, but their use for nesting was enabled by the close proximity of marine habitat. In contrast, Red-throated Loons nested on small lakes and ate a diversity of marine fishes. Despite differences in diet, both species had similar body condition, indicating that their diets met adult energy requirements. Pacific Loons had a high brood provisioning rate and fed their chicks mostly freshwater invertebrates with low-lipid content. Red-throated Loons provisioned their chicks large-bodied, energy-dense marine fishes at a much lower rate. Reproductive success over 3 years was higher in Red-throated than Pacific loons due to higher chick survival rates. Estimates of maximum energy provisioning rates for broods demonstrated that Red-throated Loons could more easily meet peak brood energy requirements than Pacific Loons. Thus, lower survival of Pacific Loon chicks was associated with lower maximum energy provisioning rates. These results indicated that differential reliance on marine resources was associated with differences in diet, breeding success, and, potentially, adaptive capacity.

## EVIDENCE OF ECOLOGICAL RELATIONSHIPS BETWEEN THE HERMANN'S GULL, THE ELEGANT TERN AND SMALL PELAGIC FISHES AND IN THE CENTRAL GULF OF CALIFORNIA

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Trophic relationships in the ecosystem are one of the main factors that influence the abundance and biomass of predators, such as marine birds. These interactions are stronger when the predator population is dependent on the availability and abundance of prey. In the central Gulf of California, populations of marine birds, such as the elegant tern (*Thalasseus elegans*) and the Hermann's gull (*Larus heermanni*) are closely linked to the abundance of small pelagic fishes. These seabirds prey mainly on Pacific sardine (*Sardinops sagax*), and Northern anchovy (*Engraulis mordax*), during the breeding season in the North central gulf. In order to explore a global view of the flux of biomass and dependency of these two marine birds on the three small pelagic fishes, *S. sagax*, *E. mordax*, and *Scomber japonicus*, we performed an analysis using the Ecopath model considering a stable stage where the small pelagic fishes were abundant and marine birds had a successfully breeding season, and its comparison with a bad breeding season and low abundance of the small pelagic fishes. Results demonstrated that small pelagic fishes are important energy transfer in the medium trophic levels from the trophic level I to V, and these prey species supported the ascendancy of predator with positive impacts on the two marine birds *T. elegans* and *L. heermanni*, and also positively impacting to marine mammals and squids. As these results showed, the Pacific sardine *S. sagax* is the main prey species that influences the abundance of marine birds due to the fact that there is a direct prey-predator relationship, and confirms the dependency for the success of marine birds and small pelagic fishes in the central Gulf of California.

## FUNDACIÓN PARA LA SUSTENTABILIDAD DEL GAVIOTÍN CHICO, AN EXAMPLE OF COMMUNITY PROTECTION FOR AN ENDANGERED SPECIES.

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The Fundación para la Sustentabilidad del Gaviotín Chico was formed 9 years ago as a public-private partnership gave life to an organization whose objective is to contribute to the protection and preservation of the Peruvian tern (*Sternula lorata*). Mejillones is the most important breeding area for this species in Chile. However, a large port with industrial facilities is located here, with plans for additional development of large industrial projects. Because of this a conservation agreement was made between regional and communal authorities and the companies that submitted their projects to the SEIA (Sistema de Evaluación de Impacto Ambiental) and have RCA (Resolución de Calificación Ambiental) favorable status. Currently the Foundation is made up of the Municipality of Mejillones and 10 companies: Codelco, Mejillones Port Complex, Angamos Electric, Mejillones GNL, Kelar, Molyb, Puerto Angamos, Sentinel, Molyb and Cochrane Electric. The Foundation has managed to form a team of game wardens who have collaborated with several scientific groups and involved community organizations and educational establishments to protect this species. The Foundation now has stewardship of 2,000 hectares for conservation, and conducts research on conservation measures and conducts annual population studies.

## LOST NUTRIENT DEPOSITION WITH SEABIRD POPULATION DECLINES IN HAWAII

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Seabirds bring vast quantities of nutrients from the ocean to coastal ecosystems where they nest. The goal of this research was to understand how much nutrient deposition may have been lost with seabird range contractions and population declines. First, we used historical accounts, sub-fossil evidence, and current knowledge of seabird species nesting requirements across the Hawaiian Islands to develop a coarse habitat-area probability model to estimate potential pre-human nesting habitat. Next, we calculated N deposition rates for 10 pelagic seabird species, corrected for different body masses, and used seabird nesting density estimates to determine how much N may have been deposited under historic high- and low-density seabird population scenarios. We estimated potential breeding habitat across all the main Hawaiian Islands in the pre-human environment at ~283,700 ha. During the pre-human era pelagic seabirds could have deposited between 1,460 and 5,290 kg of N ha<sup>-1</sup> year<sup>-1</sup> to terrestrial ecosystems. If the current population of seabirds was distributed over historic range, then density of seabirds would fall to 0.29 kg of N ha<sup>-1</sup> year<sup>-1</sup>, yielding a deposition rate of 0.535 kg of N ha<sup>-1</sup> year<sup>-1</sup>. This amounts to an estimated loss of 99.98% in N provisioning since human arrival. While this model is a coarse attempt to estimate how much nutrient may have been deposited on the island, it illustrates the amount impact on these ecosystems and the organisms that inhabit them historically, and restoring seabird habitat and population size should be a key aspect of restoring Hawai'i's terrestrial ecosystems.

## A STUDY OF THE AGE STRUCTURE, SURVIVAL, AND MOVEMENT OF THE CALIFORNIA LEAST TERN

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We re-captured and obtained records of 725 banded California Least Terns (*Sternula antillarum browni*; CLTE) with a goal of determining the age structure, dispersal and survival rates. We found that 60,516 CLTE banded between 1988 and 2016, and estimate 21,070 fledged. Of these 725 (3.4%) were recaptured. Original bandings were mostly in San Diego County between 1991 and 2011, resulting in uneven effort between sites and years. There was higher productivity of fledglings from 1997 to 2008, resulting in a “wave” moving through the population structure. Average age of the CLTE breeding has increased from 2008 to 2017 from 7.6 to 11.4 years of age. There are relatively fewer CLTE in the earlier years than later years of their reproductive life span. This may either be due to lower productivity of fledglings from the breeding colonies in recent years or lower survivorship in years 4-8 and higher survivorship in years 9-14 than predicted by Akcakaya et al. (2003). We detect fewer than expected three-year birds and 19 to 24 year birds, indicating that the peak of breeding extends from 4 to 18 years. CLTE captured between 2008 and 2017 exhibited a return rate of 34% of adults returning to the natal colony, and 38% captured within 30 km of the natal colony, or within the same “nest clusters.” Among CLTE captured multiple times we found 39% return to the natal colony in the first recapture, 62% move to a different colony. In the second recapture 93% remain at their natal colony, 79% returned to nest at the same second site, and 8% disperse to a third site. We recommend that a more regular and even effort be made to band at least 30% of fledglings annually and a goal of re-sighting and recapturing 30% of adults.

ANNUAL MOVEMENT OF *STERNULA LORATA* BREEDING IN PROVINCIA DE ANTOFAGASTA, II  
REGIÓN DE ANTOFAGASTA, CHILE.

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The Peruvian tern (*Sternula lorata*) occurs within the Humboldt Current Zone along the coast of western South America from Salinas in southern Ecuador to the península de Mejillones near Antofagasta in Chile. Populations nesting in the southern portion of the range in the Provincia de Antofagasta nest from July to December; those in northern Chile and Peru from October to February. Little is known about either group's non-breeding movements. This asynchrony gives rise to the question of if these terns nest twice in two locations, or if there is temporal separation due to nest timing between two distinct populations. In 2015 we attached archival light-level geolocators to nine individuals nesting near Mejillones and Mejia, three were recovered in 2016. All three geolocators provided a full year of recordings. We found that these three individuals remained near their capture location from September to December. All three then moved north into Peru. Although there is considerable error in these geolocators, it appears that they remained between Huanchaco, Peru and Salinas, Ecuador between mid-January and July. One individual shifted between non-breeding areas. While in Peru and Ecuador, it appears that they remain either on the coast or within coastal waters between the mainland and the Peru-Chile Trench. There is no indication from shading of the geolocators that there are second nesting attempts in Peru. It appears that there are multiple stop overs on their northward migration, and they move both south and north within Peru, taking approximately 2-6 weeks to arrive at their main wintering area. During their return from Peru to the Provincia de Antofagasta they appear to move directly, taking as little as four days.

## ARE STREAKED SHEARWATERS FAITHFUL TO THEIR PARTNERS?

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Molecular techniques have revealed striking variations in the levels of extra-pair paternity (EPP) within socially monogamous birds ranging from no extra-pair paternity (e.g. Cory's shearwaters, *Calonectris borealis*), to over half the chicks being sired by extra-pair copulations (e.g. Tree swallows, *Tachycineta bicolor*). The average level of EPP in seabirds (6.2%) is much lower than the average across all bird species (21.5%). Streaked shearwaters (*Calonectris leucomelas*) are socially monogamous, colonial seabirds that have been observed to copulate outside their social pair bonds, implying occurrence of EPP. However, parentage analysis in streaked shearwaters has been hampered by a lack of highly sensitive molecular markers such as microsatellite DNA. We developed 57 novel microsatellite DNA markers using next-generation sequencing techniques and analyzed paternity of one offspring for 64 pairs, two offspring for 11 pairs, three offspring for 9 pairs. We found that EPP ratio was 15.0% (17 out of 113 offspring) during 2014 - 2016. This value is relatively high among seabirds. We then examined if the occurrence of EPP affect their pair bonds in the next breeding season, and morphological differences in the cuckold versus non-cuckold males. In seven cases of 17, social pair did not change and reared their chick with the same partner in the subsequent year. In one nest, extra pair paternity occurred in the same pair in three consecutive years. We found that bill length of the cuckolded male was significantly shorter than average (Mann-Whitney U-test,  $U=67$ ,  $p<0.05$ ). We also discuss the differences in the behaviour between cuckolded males and other males during mating period.

## THE PRESENCE OF BIRDS AS INDICATORS OF SUCCESS OF MANGROVES REHABILITATION IN SISAL, YUCATAN, MEXICO

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This work was carried out in the occidental part of the Swamps and Mangroves State Reserve from the North Coast of Yucatan close to Sisal, Yucatan. Three sites were compared, one conserved and two disturbed at two different times after being reforested with mangrove. The site with more time after being reforested has 5 years, it has 2m trees and 2 m height. Four transects of 100 m were carried out on each site and the species were registered and its behaviour (flying, eating, resting) recorded. In total, 25 avian species were registered, from which 7 are migratory and 18 permanent residents, one endemic and one protected in the Mexican law NOM-059-SEMARNAT-2010. The more frequent behaviours birds showed were eating and resting. The most visited site was the one that has been reforested for the longest period. Due to the reduction of conserved areas in the coastal zones, these restaurated sites with mangrove species represent a valuable resource for birds, mainly migratory, because they need these sites for eating and resting in order to continue to their final destination. This was reflected with the findings of this study: major activity and avian presence in the site that has been restored for longest. Birds can be very good indicators of success of restoration programs in coastal zones, mainly because of the presence of migratory birds.



## POPULATION OF *STERNULA LORATA* IN THE RESERVA NACIONAL DE PARACAS

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*Sternula lorata* is a species endemic to the Humboldt Current under serious conservation threats. These include habitat loss and disturbance in its breeding areas. The population has declined since the original estimate of 10,000 individuals made in 1984. The Reserva Nacional de Paracas is a Natural Protected Area in Perú that is recognized internationally as a Ramsar site because of its high primary productivity that supports high species diversity in its many habitat types that provide feeding, resting, and breeding areas for many species, including *S. lorata*. This study reviews the population status of *S. lorata* on the Paracas peninsula by providing a population estimate and nest counts in that area. This information will inform strategies to conserve this threatened species and manage the natural resources of the Reserva Nacional de Paracas.

SALMON FINGERLINGS PREDATION BY AVIAN PREDATORS NEAR A SALMON HATCHERY IN OHTSUCHI, THE SANRIKU REGION, JAPAN

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Predation has been suggested to be a major source of natural mortality for Chum salmon *Oncorhynchus keta* fingerlings (0+ year-old) during their early marine life. However, the predation risk faced by the fingerling just after they are released from the hatchery into the river and enter the ocean is poorly known. In this study (March 2016 to May 2017), coastal and river surveys in the Ohtsuchi were conducted, and we confirmed that 16 avian species foraged on the fingerlings around the survey area. We also conducted fixed point observations at the river near the hatchery to determine predation rates of fingerlings by avian predators. During February to March, Slaty-backed gulls *Larus schistisagus*, Great cormorants *Phalacrocorax carbo*, Great egrets *Ardea alba*, Grey herons *A. cinerea* and Common mergansers *Mergus merganser* were the major avian predators. During April to May, Black-tailed gulls *Larus crassirostris* were the major avian predators and several cormorants, egrets, herons and mergansers occasionally joined those feeding flocks. The estimated maximum predation rate was 0.52% in April to May (6700 fishes / 1 million released fingerlings) and 1.75% in February to March (17800 fishes / 1 million released fingerlings). We concluded that Chum salmon fingerling might be the important prey option for avian predators during early spring, but that the predation rate might not be very high in the Otsuchi area.

## SEABIRDS AS INDICATORS: UNDERSTANDING VARIABILITY IN MARINE PRODUCTIVITY AND PREY COMMUNITIES THROUGH LONG-TERM STUDIES OF REPRODUCTION, FORAGING EFFORT, AND DIET

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Seabirds must cope with extreme variability of prey in upwelling ecosystems including the California Current System (CCS). They are uniquely observable, deriving food from the marine environment, yet are constrained to the ocean's surface and terrestrial nesting locations; as such, aspects of their biology have the potential to indicate ecosystem condition and change. Colony-based monitoring of reproduction, time allocation, and chick diet of Common Murre (*Uria aalge*), the most abundant seabird nesting in the CCS, can provide insight into murre population dynamics, as well as regional variability of prey populations. We characterized murre reproductive performance, foraging effort (as indicated by colony attendance patterns and chick provisioning), and the composition of the prey community within flight distance of one of the largest colonies in the CCS, Castle Rock, using a 11-year time series (2007-2017). The timing of nest initiation varied annually ( $P < 0.001$ ,  $n = 820$ ), and was positively related to and followed the onset of upwelling ( $P = 0.009$ ,  $r^2 = 0.54$ ,  $n = 11$ ). The ability of murre to hatch eggs and fledge chicks also varied annually, with poor success in 2016 and complete breeding failure in 2017 due to starvation. In years where chick starvation was frequent, chick-rearing pairs dedicated more time to foraging, often leaving chicks unattended for prolonged periods to maximize time searching for prey. Prey communities, as inferred from chick diet, varied annually ( $P < 0.0001$ ,  $n = 144$ ), with years of poor reproduction deviating most from the average condition. Consequently, several metrics can serve as rapid and early indicators of regional marine productivity and prey communities with continued monitoring.

## HARMFUL ALGAL BLOOMS, SEABIRDS, AND FORAGE FISH: ASSESSMENT OF TOXINS DURING AND AFTER THE 2015—2016 COMMON MURRE DIE-OFF

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An unusually large number of Common Murres (*Uria aalge*) died in the Northeast Pacific Ocean during 2015—2016 in association with an anomalously warm ocean water event dubbed “The Blob.” The proximate cause of murre mortality was starvation, which appears to have resulted from a shortage of available forage fish. However, birds may have also been exposed to harmful algal blooms (HABs), raising questions about the possible role of algal toxins in the murre die-off. To address these concerns, we tested for the HAB neurotoxins domoic acid (DA) and saxitoxin (STX) in a suite of seabird tissues from deceased Common Murres associated with the 2015—2016 die-off, as well as from apparently healthy murres, Black-legged Kittiwakes (*Rissa tridactyla*), and samples of forage fish and invertebrates that were collected during the following summer. DA occurred rarely and only at trace concentrations in both bird and forage samples. In contrast, we detected STX across multiple tissue types in both healthy and die-off birds as well as in forage samples. No reference values currently exist for seabirds, but concentrations of STX in most individuals were low, and we found no evidence that acute exposure to algal toxins was a direct cause of Common Murre mortalities. Nevertheless, our results demonstrate the widespread occurrence of STX in seabirds and forage samples across multiple seasons and geographic locations in Alaska, and suggest that HABs should be considered in future assessments of seabird health, especially given the potential for greater occurrence of HABs in the future.

## WHAT MIGHT YOU DISCOVER USING ARCHIVED SEABIRD EGGS

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Seabird eggs have been touted as excellent specimens for biomonitoring and as such have been archived by multiple countries and institutions. The Seabird Tissue Archival and Monitoring Project (STAMP) has archived approximately 2300 eggs from 75 colonies throughout Alaska and the US Pacific Islands. Murres (*Uria* spp.) were first collected in 1999, with the addition of gulls (*Larus* spp.) between 2004 and 2010, and albatross (*Phoebastria* spp.) in 2010 as well as a few other seabird species using standardized collection, processing and archiving protocols. The egg contents are separated from the shells and the contents are homogenized before aliquoting into perfluoroalkoxy alkane (PFA) jars and polypropylene vials and stored in liquid nitrogen vapor-phase (-150 °C) freezers. The shells with membranes were originally cleaned, dried and stored at room temperatures, but since 2015 have been weighed fresh and stored in plastic bags in -80 °C freezers. Samples are stored at the NIST Marine Environmental Specimen Bank in Charleston, SC. These collections allow for temporal, geographical and species comparisons. Legacy organic contaminants and mercury have been analyzed in many of the samples. Researchers have also examined samples for contaminants of emerging concern, stable isotopes, and genetics. Multiple uniform and reproducible aliquots of each sample are available to researchers through a tissue access policy. How would you propose to further your research using these high quality seabird egg samples?

## A NEW GLOBAL BIOGEOGRAPHIC SCHEME FOR SEABIRDS: THE IMPORTANCE OF SEA SURFACE TEMPERATURE AND SALINITY IN STRUCTURING SEABIRD ASSEMBLAGES

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Seabirds have been traditionally excluded from any attempt to define bioregions at global scales. In this work, for the first time, we make a global classification of bioregions based on the at-sea distribution of 359 species of seabirds. To identify these bioregions (geographically distinct assemblages of species and communities) we employ the network theory-based InfoMap algorithm, which allows to identify biogeographic regions using species distribution data. In addition, we evaluate the importance of 16 environmental variables explaining the biogeographic structure through a machine-learning random forest model. The results show the existence of nine clearly delimited bioregions worldwide. This new biogeographic scheme show a clear spatial structure related to major oceanographic domains and a high correspondence with early regional biogeographic studies for seabirds. The random forest models show a very high fit (pseudo  $r^2 > 0.98$ ). From the 16 environmental variables tested, sea surface temperature and salinity stand out as the most important factors for the biogeographic structure observed. These two variables are two of the most discussed physical variables thought to be important for explaining marine biogeographic structure and individual species distribution. However, its importance for seabird species distribution may have been underestimated. Our results highlight the importance that these two factors have in community spatial structure and composition for seabirds at large geographic scales. Hence, the global changes in oceanographic conditions forecasted for the next decades may have a deep impact on the biogeographic structure and conservation of seabirds.

## GROWTH AND SURVIVAL OF ATLANTIC PUFFIN CHICKS IN RELATION TO DAILY PROVISIONING RATES

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In 2013, Atlantic Puffin (*Fratercula arctica*) chicks in the Gulf of Maine were starving, despite receiving a diet composed primarily of “good” forage fish such as Atlantic herring (*Clupea harengus*) and white hake (*Urophycis tenuis*). To investigate the importance of daily provisioning rates to the growth and survival of puffin chicks, separate from diet composition, we conducted all day feeding watches at a subset of nests, twice per week, throughout the chick rearing period from 2014-2017, at three mid-coast Maine colonies. Productivity, chick growth, and mean daily provisioning rates exhibited significant interannual variation, and results suggest provisioning rate is an important factor in chick growth rates and reproductive success.

## LIGHT ATTRACTION IN STREAKED SHEARWATER FLEDGLINGS: THE EFFECTS OF TURNING EXTERNAL LIGHTING OFF

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Although the widespread mortalities of shearwaters and petrels attracted to artificial lights have been reported, few experimental studies have explored mitigation actions. This study examined the numbers of streaked shearwater, *Calonectris leucomelas*, fledglings attracted to artificial lights on Awashima Island in the Sea of Japan and assessed the mitigating effects of reduced artificial lighting in the village. The numbers of fledglings grounded in Uchiura Village on the island were recorded nightly in October and November from 2011 to 2014. To assess the effects of an experimental reduction in light emissions, the external lights in the village were turned off during the fledgling season in 2013. We collected 104, 1146, 17, and 342 birds in 2011 to 2014, respectively. The reduction in external light emissions in 2013 caused a significant decrease in the numbers of grounded fledglings. Our results indicate that reducing light emissions is effective for decreasing the number of streaked shearwaters attracted to artificial lights. Although complete elimination of external lighting may be impractical, lighting management in the village is one mitigation action for streaked shearwater fledglings.



## MIGRATORY SEABIRDS TRANSPORT MERCURY FROM MARINE TO TERRESTRIAL ECOSYSTEMS

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Mercury is a ubiquitous element that is potentially harmful to marine top predators. While physical systems, such as currents and winds, have traditionally been considered responsible for transporting semi-volatile contaminants, evidence is mounting that animals play a non-negligible role in this process through their movements. However, we know little about how such transportation affects the site where biological deposition occurs. Here, we used as a model system the rhinoceros auklet (*Cerorhinca monocerata*), a seabird that occurs in immense colonies (~300,000 pairs at our study site). Through joint analysis of mercury concentration and stable isotopes in the birds' blood and feces, as well as in plants within and outside of the breeding colony, we assessed the extent to which marine-derived mercury transported by auklets spreads to plants. Levels of mercury, and of three eight other metal and metalloids, were higher in plants near the auklet colony compared with control sites. Altogether, our results show that rhinoceros auklets transport marine-derived mercury, possibly from their wintering location, and deposit it *via* their feces at their breeding site, hereby contaminating plants within the breeding colony. This direct evidence of mercury biotransport, from a marine to a terrestrial ecosystem, demonstrates the existence of biotransport of contaminants across ecosystems, potentially over unexpectedly long distances.

## COMMUNITY-BASED LEAST TERN (*STERULA ANTILLARUM*) CONSERVATION IN LOS CABOS, BCS-MEXICO: INTEGRATING SCIENCE AND CULTURE

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Approaches to the conservation of wildlife that involve the participation of local communities are now being widely promoted. This report presents a case study of community-based conservation program of Least tern (*Sterula antillarum*), designed to protect nesting areas by providing technical assistance in sustainable wildlife management practices and financial incentives for communities. The program is being implemented by local government, with the assistance of Organización SyCOMA (Organización para la Sustentabilidad y la Conservación del Medio Ambiente), CIBNOR (Centro de Investigación Biológicas del Noroeste), ITES Los Cabos (Instituto Tecnológico de Estudios Superiores de Los Cabos) and other non-governmental and international organizations, in the Municipality of Los Cabos, BCS-Mexico. The Program has been active for 17 years. As illustrated in this case study, it has a well-designed and tailored approach for integrating community involvement at conservation. The program faces significant challenges, but benefits from the support of local governments, hotels and universities, nonprofit organizations as well as the experiences of prior CIBNOR conservation efforts. By connecting with the key players, the SyCOMA Organization team went from protecting one nesting colony to nine, and has different community actors participating in the conservation of the throughout the municipality.

## WHERE DO “COASTAL” SEABIRDS GO? THE CASE OF THE BLACK VENTED SHEARWATER

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During the breeding season, among ocean wanderers like the shearwaters, foraging trips are constrained by nest attendance schedule and are necessarily colony centered. Nonetheless, oceanographic cues play a major role in the choice of foraging areas to minimize the time spent away from the nest. We tracked Black-vented Shearwaters (*Puffinus opisthomelas*), BVSH, during the brooding and chick-rearing periods during the 2016 and 2017 breeding cycle at Isla Natividad (Mexico). We applied expectation-maximization binary clustering, binary generalized linear mixed models, and kernel estimation techniques. In 2016, breeding BVSH used two core areas used for foraging and resting on the water; the male northward and the female southward from the colony. In 2017, the males and females used the same areas with no evident segregation. We present the first information on BVSH foraging areas during the breeding season and indicated that sexual segregation along the coastal waters of central Baja California peninsula may be a foraging strategy characteristic during warmer years. We inferred the annual migrations and variations in trophic ecology of both members of breeding pairs analyzing GLSs and stable isotopes of C and N in feathers and found that they migrate to similar terminal nonbreeding areas. Although foraging levels were alike during winter up to incubation period, they were not identical and they mostly differed during late breeding period. Our results suggest behavioural coordination shifting to different trophic levels during breeding period in order to avoid competition and maximize foraging efficiency during chick rearing.

BREEDING AND BEHAVIOR OF THE TOWNSEND'S SHEARWATER (*Puffinus auricularis auricularis*), AN ENDEMIC SEABIRD TO THE REVILLAGIGEDO ARCHIPELAGO, MEXICO.

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Townsend's Shearwater (*Puffinus auricularis auricularis*, TOSH) is a critically endangered species, endemic to the Revillagigedo Archipelago, Mexico. Historically, this species nested on San Benedicto, Socorro and Clarión islands, but due to impacts caused by invasive mammals (i.e., pigs, sheep and cats) and volcanic eruptions, its population was reduced to a few tens that remain on Socorro. As part of our seabird restoration and monitoring program, we present the most recent results of its breeding biology and behavior. During breeding seasons 2016 and 2017, we carried out auditory surveys, burrow searches, and installed song meters and camera traps to detect active periods, calling rates, presence, activity, and reproductive success, both on Socorro and Clarión islands. We located 14 active sites and 16 burrows on Socorro; 81% were active and had a productivity of 54%. We also found two burrows on Clarión but productivity was not confirmed. Calling rates were usually constant on both islands during breeding pair formation, they decreased after egg laying, and were not detected in the chick-rearing period. Our results confirm that a small breeding population of TOSH remains on Socorro, and that the species recently returned to nest on Clarión. Conservation efforts must be sustained in the long-term in order to preserve this endemic species.

PRODUCTIVITY RESPONSE BY ENDANGERED HAWAIIAN PETRELS TO ECOSYSTEM-LEVEL  
PREDATOR CONTROL ON THE ISLAND OF LĀNA'I

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Lāna'i is the sixth largest of the Hawaiian Islands and the smallest publicly accessible inhabited island in the archipelago. Though the island has experienced severe habitat degradation due to ranching, agriculture, non-native ungulates, and invasive plants, it is still home to one of the largest nesting concentrations of endangered Hawaiian Petrels (*Pterodroma sandwichensis*). As with many seabird colonies, predation by non-native mammals is a substantial source of mortality for both adults and chicks. In 2016, around 80% of nests failed, mostly due to predation by rats and cats. For the 2017 breeding season, Pūlama Lāna'i's wildlife program responded by increasing the level of cat control from previous efforts and newly implementing control grids of rat traps. Rat control consisted of a 100x50m network of Goodnature A24s covering >35 ha of the core petrel colony, plus additional coverage of smaller supporting colony areas, with traps spaced <50x50m. Use of new Automatic Lure Pumps (ALPs) from Goodnature provided much greater personnel efficiency, allowing for deployment of many more traps (500+) than would have been possible with the traditional bait method, which requires re-baiting every 3-6 wks. The majority of traps with ALPs on Lāna'i are continuing to function properly even 4-6 months after installation. While predator control efforts can always be improved upon, preliminary results from the 2017 petrel breeding season indicate a significant increase in productivity in the areas where rat and cat control was concentrated. Future analyses will look more carefully at the interactions between predator control effort, predator activity in and around the colonies, capture rate, and petrel reproductive success.

BAILING ON THE CALIFORNIA CURRENT: MARBLED MURRELET AND OTHER SEABIRD RESPONSE TO UNUSUAL CONDITIONS IN OREGON AND NORTHERN CALIFORNIA

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An unprecedented shift in Marbled Murrelet (*Brachyramphus marmoratus*) distribution in Oregon and abrupt failure of Common Murre (*Uria aalge*) nesting in northern California indicate a collapse in the higher trophic levels along at least 600 km of coastal California Current in 2017. Until this year, upwelling processes and ecosystem function in the California Current off Oregon and northern California appeared to be a haven of near 'normal' conditions for seabirds in an ocean of change. This changed during summer 2017, when we recorded a complete failure of Common Murres nesting at Castle Rock National Wildlife Refuge and mass emigration of Marbled Murrelets from Oregon into California. A description of oceanographic parameters, cormorant nesting success, and forage fish indicators are examined to clarify factors contributing to the collapse.

NESTING OF *STERNULA LORATA* (GAVIOTÍN PERUANO OR GAVIOTÍN CHIRRÍO) AT 13 AVO MANGROVE RAMSAR SITE OF SAN PEDRO, SECHURA-PIURA, NORTHWEST OF PERU

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In South America the *Sternula lorata* (Peruvian tern or gaviotín chirrío) has 12 breeding sites along the South American Pacific coast, 8 in Chile and 4 in Peru. The present investigation was carried out in the Mangrove Ramsar Site of San Pedro, Piura 80°52'50 " LO 05°32'10 " LS from 2011 to 2017 during the austral summer and winter. The methodology was by transects at the edge of the mangrove and intensive searches in the surrounding desert. Six nests were recorded in 1.1 ha of desert: two nests with 1 egg, three with 2 eggs, and one with 4 eggs. Four of the nests were surrounded by calcareous remains of bivalves and 2 protected by *Batis maritime*, the temperature of the nests it fluctuated between 23 and 33 ° C during February and March 2017. The nesting area was 1.8 km distant from the sea was 1.8 km, and 2.5 km distant from the mangrove, and between nests the greatest distance was 1.3 km and the smallest 0.1 km. We observed behaviors of courtship and transfer of food such as *Engraulis ringens* (anchoveta) from the intertidal zone to the nesting area. The main threats are the *Lycalopex sechurae* (coastal fox), because of evidence of its footprints in the nesting area, and vehicular traffic. The present investigation confirms the nesting of *S. lorata* in San Pedro Mangroves, making it the northernmost nesting site of the species on the coast of South America.

## SEABIRD BYCATCH IN PURSE SEINE FISHERIES: STATUS OF KNOWLEDGE AND MITIGATION MEASURES

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Purse seine fisheries are globally distributed but scarcely understood in regard to their impacts on non-target species. Knowledge on bycatch issues was restricted to interactions with purse seine vessels targeting tuna and the conservation actions focused mainly on megafauna such as dolphins. We reviewed the available information on seabird bycatch related to purse seine fisheries in different major fishing regions, including descriptions of bycaught seabird species and any mitigation measures tested. Seabird bycatch was identified for seven FAO s marine areas, involving eight countries in North America, South America, Europe and Oceania. A total of 33 seabird and 2 waterbird species were affected as bycatch. Species involved ranged from a single species in Western Australia to 17 species in the Gulf of California. Along the east Pacific, the pink-footed shearwater *Ardenna creatopus* was affected in the Gulf of California and the Chilean section of the Humboldt Current. Overall, among the 35 species bycaught, 23 species had a conservation status of Least Concern, eight of Near Threatened, one of Vulnerable, three of Endangered, and one of Critically Endangered. Seabird bycatch in purse seine fisheries occurs on a global scale with some threats identified for industrial and small-scale fisheries but information gaps remain in several regions. Finally, the promotion of experimental initiatives to test potential mitigation measures is necessary.



## TOWARDS THE DEVELOPMENT OF NOVEL MITIGATION MEASURES IN PURSE SEINE FISHERIES

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The Modified Purse Seine (MPS) is one of the first proposed measures to mitigate seabird bycatch in purse seine fisheries, and results from collaborative work between fishers, vessel owners, fishing gear manufacturers and seabird researchers. Empirical data from in situ monitoring under commercial conditions identified sources of seabird bycatch in purse seine gear and informed the design of innovative technical mitigation measures, with an emphasis on diving seabird species. This document presents the MPS as a complementary measure for best practice to mitigate seabird bycatch in these globally distributed fisheries.

UPDATE ON THE U.S. FISH AND WILDLIFE SERVICE PACIFIC SEABIRD PROGRAM:  
ACCOMPLISHMENTS AND PILOT PROJECTS TO FOSTER COLLABORATION FOR SEABIRDS IN THE  
PACIFIC

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The Pacific Seabird Program, which is a new USFWS program under the National Wildlife Refuge System's Inventory and Monitoring Program, is a collaborative endeavor involving the USFWS Migratory Birds and Habitats Program, State agencies, other Federal agencies, Canada, and private partners. Since the program's inception at the 2015 PSG Meeting, we have successfully conducted several pilot projects to encourage collaboration and build partnerships along the Eastern Pacific Rim to better coordinate seabird monitoring across large geographic scales. With input from participants at a 2016 USFWS-sponsored meeting in Portland Oregon, we drafted and finalized a national Protocol Framework for breeding Common Murres (*Uria aalge*) and Brandt's Cormorants (*Phalacrocorax penicillatus*) for the California Current System (CCS). In July 2017, we convened seabird biologists from the U.S. Tropical Pacific (USTP) in Honolulu to participate in a seabird gap analysis to discover what information is being collected on seabirds in this area. Another outcome of the Honolulu workshop is a seabird monitoring manual which describes standard and accepted monitoring techniques for USTP seabird species, depending on the sampling objectives. The successful completion of these pilot projects demonstrates that large-scale collaboration for seabirds is possible among diverse partners. Our next project will develop standardized databases within which data can be stored for seabird species across their ranges. Moving forward, it will be vital to maintain and develop relationships with partners in the CCS, Alaska, the USTP, British Columbia and Mexico order to conduct coordinated, robust and efficient seabird monitoring across the Pacific.

## EVALUATING THE RELATIONSHIPS BETWEEN WEATHER AND NANOTAGGED TERNS USING R-SHINY

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In December of 2016, America's first offshore wind energy facility became operational three miles south of Block Island, Rhode Island. Seabirds of high management priority, the Common Tern (*Sterna hirundo*) and the Federally endangered Roseate Tern (*S. dougallii*), nest within 50-km of Block Island and are known to forage in the area. Our objective was to determine when terns were most active within the vicinity of Block Island to contribute to preliminary assessments of macro-level exposure. We analyzed the linear relationships among tern detections and temperature, wind speed, wind direction, dew point, humidity, barometric pressure, chick age, tidal height, date, precipitation, and visibility from the summer of 2016, before the turbines became operational. Tern detections peaked in early July, when chicks were around 14 days old. We found negative associations among tern detections and poor weather conditions. Tern detections coincided with low and rising tides, which may have been due to the positive effect of low tides on food availability. The highest number of detections occurred at 4-6 meter per second wind speeds, which is just above the cut-in speed of the turbines. We developed an interactive R-Shiny application to present these results to managers. Our application will ultimately allow researchers and agencies such as the Bureau of Ocean Energy Management and U.S. Fish and Wildlife Service to explore relationships between weather patterns to tern abundance around Block Island. Such information is important to support management decisions for minimizing the potential impact of offshore wind turbines on wildlife, as the United States continues to expand into the field of renewable energy.

## ALEUTIAN TERN MONITORING IN THE KODIAK ARCHIPELAGO

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The Alaskan population of Aleutian terns (*Onychoprion aleuticus*) has declined by more than 80% at documented colonies over the past three decades, and the reasons for this decline are unknown. During the 2017 breeding season, we monitored Aleutian tern colonies in the Kodiak Archipelago to collect behavioral and ecological data to assist in identifying potential threats and conservation actions. Trail cameras were placed on the nests of Aleutian terns and neighboring nesting seabird species to determine nest survival rates, causes of nest failure, and information on prey types being provided to chicks. A total of 19 cameras were set, including cameras at 15 active Aleutian tern nests. Only two camera nests survived to hatching. Twelve nests failed due to various predators including mew gulls (*Larus canus*), black-billed magpies (*Pica hudsonia*), northwestern crows (*Corvus caurinus*), red foxes (*Vulpes vulpes*), domestic sheep (*Ovis aries*), and egging by local people. The cameras captured images of 148 chick provisioning events at two Aleutian tern nests. In addition to monitoring nest status, we collected nest-site habitat data and used Linear Discriminant Analysis to compare the vegetation characteristics of Aleutian tern, Arctic tern (*Sterna paradisaea*), and mew gull nests to one another and the surrounding available habitat. Our data suggests that high predation rates may be an important influence on Aleutian tern productivity; however, we do not know what effects prey availability, nesting habitat suitability, and interactions with associated nesting species may be having on Aleutian tern populations in the Kodiak Archipelago.

## PREDATOR-MEDIATED EFFECTS OF DROUGHT ASSOCIATED WITH POOR REPRODUCTIVE SUCCESS IN A NOCTURNAL SEABIRD IN A CROSS-ECOSYSTEM CASCADE

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Despite the profound impacts of drought on terrestrial productivity in coastal arid ecosystems, only a few studies have addressed how drought can influence ecological cascades across ecosystem boundaries to impact seabirds. In this study, we examined the consequences of ENSO-driven rainfall pulses and drought that subsequently impact the breeding success of a small nocturnal seabird, the Scripps's Murrelet (*Synthliboramphus scrippsi*). On an island off the coast of southern California, the main cause of reduced nest success for one of their largest breeding colonies is egg predation by an endemic deer mouse (*Peromyscus maniculatus elusus*). Mice on the island have an opportunistic diet of primarily terrestrial sources, but drastic declines in terrestrial productivity from drought might be expected to increase their reliance on marine resources, including murrelet eggs. We compiled data on indicators of terrestrial and marine productivity between 1993-2013 to determine how conditions in these ecosystems affect murrelet nest success. Seabirds are often heralded as sentinels of ocean climate variability and change. In this study, however, we found that murrelet nest success since the 1990s was instead mainly associated with the severity of drought. Murrelet nest success was substantially lower when egg predation was higher under severe drought conditions. Nest success was much better under normal or high rainfall conditions, but how much higher depended on whether oceanic conditions were favorable to murrelets. Therefore, the threat of both more frequent and severe droughts resulting from global climate change along with changes to the ocean has worrisome implications for murrelets on this island.

## BIRDS CONSERVATION AS A STRATEGY FOR SUSTAINABLE TOURISM DEVELOPMENT IN LOS CABOS, BCS MEXICO

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The municipality of Los Cabos, located at the southern tip of the peninsula of Baja California, is a true Eden where the sea and the desert merge harmoniously. It is a place of sandy beaches bathed by the waters of the Pacific Ocean and the Gulf of California, which is surrounded by desert ecosystems, thorny shrubs and oases that are the natural habitat of native and migratory birds. In Baja California Sur, more than 400 species of birds have been reported, of which 6 are endemic; in Los Cabos we can find practically all, among which 4 endemic species stand out. In order to promote the conservation of the local avifauna and knowledge of the abundant biodiversity of Mexico, in 2000 the municipal government initiated a program aimed at the protection of the least tern (*Sternula antillarum*) after 17 currently years of work actuality has an Avifauna Conservation Program that has 6 axes of action which are: Protection and Surveillance; Culture and scientific dissemination for environmental sustainability; Community Involvement; Generation of economic alternatives; Research and Tourism as a strategy for the conservation and sustainable development of Los Cabos. The research presents the Program as a methodological proposal for sustainable development in the region.

ADDRESSING SEABIRD BYCATCH IN THE PACIFIC COAST GROUND FISH FISHERY:  
COLLABORATION LEADS TO FEASIBLE CONSERVATION MEASURES

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A short-tailed albatross (*Phoebastria albatrus*) was killed in Pacific Coast Groundfish Fishery (PCGF) off the Oregon Coast in 2011. Since then, agencies, researchers, and fishermen have taken steps to minimize seabird bycatch in the fishery. Despite requirements to use bird scaring lines (BSLs) on vessels 55 feet (16.7 m) and over, estimates of injury and mortality were higher than anticipated. Researchers examined the effectiveness of and alternatives to BSLs. BSLs were found to be effective with sinking gear, but streamers were not effective with the floating gear used by approximately half of the PCGF longline fleet. Observer data indicated that albatross attack rates were similar on vessels larger and smaller than 55 feet; and bycatch was 30 times lower and target catch was 42% higher when lines were set at night (after civil sunset). Preliminary observations of the at-sea hake catcher-processors indicated that black-footed albatrosses struck aerial trawl cables at higher rates than expected. These data were used to develop the most recent proposed requirements for the PCGF fleet, including the use of BSLs on all longline vessels greater than 26 feet (7.9 m) or setting longlines after civil sunset, requirements to examine alternative methods for bird deterrents with floating longline gear, continued examination of interactions and effective bird deterrents for the catcher-processor fleet, and improved record-keeping to better inform estimates of mortality and injury. The continuing collaboration among agencies, researchers, and industry on the U.S. west coast is a successful example of implementing effective measures for minimizing seabird interactions.

## FORAGING MOVEMENTS AND OCEANIC HABITAT USE OF RED-TAILED TROPICBIRDS BREEDING ON OAHU, HAWAII

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The Red-tailed Tropicbird (*Phaethon rubricauda*) is common throughout the tropical Indian and Pacific Oceans, yet there is little information about its behavior at sea, particularly in the central Pacific where there are sizeable breeding populations in the Hawaiian Islands. We GPS-tracked adult chick-rearing tropicbirds (n=22) from a colony on Oahu during April–May 2017 to collect information on their distribution and habitat use at sea. The duration of foraging trips ranged from short, intra-day outings to long, multi-day trips over 800 km from the colony and lasting up to 10 days. The primary foraging areas used by tropicbirds during short trips were located relatively close to the colony, along the insular shelf break to the southwest of Oahu (depth 1000–3000 m). Most long-duration trips were to the south of Oahu where individuals appeared to utilize waters associated with seamounts; however, the two longest foraging trips were in more pelagic waters to the northeast. We suggest that during long-distance foraging trips, tropicbirds may be using additional oceanographic features (e.g. eddies) as pelagic foraging habitat. Quantifying ranging behaviors of tropicbirds at sea and describing important foraging habitats throughout Hawaiian waters is crucial for informing marine spatial planning and conservation, especially given the current interest in developing offshore wind energy infrastructure. Preserving existing high-island nesting colonies and associated colony-specific foraging areas will also become important as tropicbirds breeding on low-lying atolls in the Northwestern Hawaiian Archipelago risk displacement due to sea level rise and storm inundation.



## POPULATION LEVEL IMPACTS OF POWER LINE COLLISIONS ON THE ENDANGERED NEWELL'S SHEARWATER AND HAWAIIAN PETREL

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On Kaua'i, both the Newell's Shearwater (*Puffinus newelli*) and Hawaiian Petrel (*Pterodroma sandwichensis*) are vulnerable to power line collisions because they make frequent nocturnal flights to and from mountain breeding colonies, often crossing over power lines in the process. To determine collision rates on Kaua'i, we have conducted 5,052 hours of observations from 2012-2017 quantifying seabird power line collisions, flight height, and behavior at power lines. We have also developed a novel monitoring tool - automated acoustic surveys of avian power line collisions - which has dramatically increased the temporal and spatial scale of monitoring (276,879.5 total hours), overcoming many of the biases inherent in traditional bird carcass counts. Based on our observations, we report that 9.3-15.3% of seabird power line collisions result in an immediately grounded bird and use this as a proxy for minimum mortality. Automated acoustic surveys at a sample of sites along the entire power line grid detected a total of 3,482 collisions between 2013 and 2016. We developed a statistical model to predict collision risks across the island-wide transmission wire grid, and estimated a total of 10,552 collisions per year. We estimate that minimum mortality is between 981-1,614 endangered seabirds killed at power lines annually. We validated our model estimates both statistically and with orthogonal data sets and discuss practical ways to minimize these collisions. These results show that power lines collisions are the largest documented source of mortality for two declining populations of endangered species and are consistent with recent studies which have shown significant, large-scale population declines on Kaua'i.

## EXAMINING THE BEHAVIORAL BENEFITS OF LONG-TERM PAIR BONDS IN A SMALL AUKLET

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Long-term pair bonds are a conspicuous trait of many seabirds. Such perennial monogamy is typically viewed as adaptive due to improved breeding coordination for more experienced pairs. Yet while beneficial “mate familiarity effects” have received some empirical support, it is largely unknown which specific behaviors improve with pair-bond duration. In this study, we investigated whether a critically important coordinated behavior, incubation synchrony, differed between new and experienced pairs of Cassin’s auklets (*Ptychoramphus aleuticus*) breeding on Southeast Farallon Island. An analysis of 37 years of breeding data indicated that more experienced pairs had higher hatching rates than their inexperienced counterparts. In 2017, we explored a possible behavioral mechanism underlying this pattern using a high-resolution automated nest monitoring system to track the frequency of egg neglect among new and experienced pairs. Egg-neglect primarily lasted one day and was uncommon, though the frequency did vary between pairs. We found, however, no relationship between breeding experience or age and the frequency of egg neglect. This suggests that incubation synchrony does not improve or diminish with mate familiarity and thus may not account for the positive relationship observed between pair-bond duration and reproductive success. Further work will be required to determine whether this finding is observed in environmentally poor years, in which synchrony might be especially challenging to maintain.

## RESTING METABOLIC RATE OF RHINOCEROS AUKLETS IN AIR AND ON WATER

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Many seabirds spend most of the time at the sea and rest on cold seawater, except for visiting their breeding colony. Since thermal conductivity is 25 times higher in water than in air, seabirds resting on sea lose their heat easily and expend large energy for thermoregulation. We measured resting metabolic rate (RMR) in air and on water of adult Rhinoceros auklets *Cerorhinca monocerata* breeding in Teuri Island, Hokkaido Japan, from May to July 2015-2017. Forty-three auklets were captured at a breeding colony and measured their resting metabolic rate by using an open flow respirometric system. At the lower temperature, RMR on water ( $6.1 \pm 0.7^\circ\text{C}$ ) was 174% higher than those in air ( $5.0 \pm 0.4^\circ\text{C}$ ). At higher temperature, RMR on water ( $16.0 \pm 1.0^\circ\text{C}$ ) was 131% higher than those in air ( $15.2 \pm 0.3^\circ\text{C}$ ). RMRs on water increased with decreasing water temperature, but in air there was no effect of temperature ( $5.0$ - $20.3^\circ\text{C}$ ) on RMRs. Ratio of RMR on water to in air at ca.  $16.0^\circ\text{C}$  was 1.3. This ratio is similar to those of thick-billed murres (*Uria lomvia*), which would be related to mass of their body feathers.

## WHAT DO MASKED BOOBIES (*SULA DACTYLATRA*) EAT IN THE GULF OF MEXICO?

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Masked boobies (*Sula dactylatra*) in Arrecife Alacranes in the Gulf of Mexico have two breeding peaks (spring and autumn) during the year. We wanted to compare if differences in diet existed between these peaks and in a near future relate the diet with breeding success and fisheries. Diet was obtained from breeding Masked booby adults in 2013 (spring and autumn) and 2014 (autumn) while handling them during ringing procedures. We obtained similar sample numbers of males and females. The prey items differed between spring and autumn within and between years. We found that the main prey item in the spring of 2013 was *Cypselurus melanurus* with 53 % of the regurgitates containing it. In the autumn of 2013, the most abundant prey was *Sardinella* spp., present in 43% of the regurgitates, while in November 2014 it was *Cypselurus melanurus*, and was present in 62% of the regurgitates. The less abundant prey item in the spring of 2013 was *Euleptorhampus velox* (6%), in autumn 2013 the less abundant was *Parexocoetus brachypterus* (7.14%) and in 2014 it was *Exocoetus volitans* and one individual of the Loliginidae family (3.45% for both). No differences were found in the prey items between sexes. The mean weight of the samples differed between breeding peaks as well. This information is important in order to know and understand seasonal changes and try to relate it with breeding success and fisheries data from the zone. In the future we will use the diet data to estimate if a relationship exists between the amount of commercial fish obtained, the breeding success and the diet of Masked boobies.

AGGREGATION BY MULTIPLE SEABIRD SPECIES TO RAPIDLY GROWING STOCKS OF SAND LANCE  
(AMMODYTES, SPP.) IN MASSACHUSETTS

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During the late 1970s and early 1980s abundance of several species of seabirds, including shearwaters, alcids, kittiwakes and large gulls reached historical maxima of abundance at very large feeding aggregations along the Massachusetts coast. The size of these aggregations subsided following the subsequent decline of sand lance (*Ammodytidae*), and seabird abundance declined to more usual levels by about 1985. Beginning about 2005, abundance of sand lance has once again increased to levels approaching and exceeding those of the late 1970s. Record abundance of Northern Fulmars and alcids, especially Razorbills, shearwaters, kittiwakes and jaegers are most prominent now. We use this example of spectacular rise and fall of abundance to illustrate the linkage between populations of seabirds and fishes in the Northwest Atlantic.

## SEABIRD BYCATCH BY PURSE-SEINE SMALL PELAGIC FISHERY IN THE GULF OF CALIFORNIA

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Bycatch in fishing gear is one of the most important causes of seabird mortality. An observers program was carried out between 2013-2014 onboard ships of the small-pelagic fishery from Sonora, which operates in the central Gulf of California. This program, in collaboration with the fishing industry, fisheries authorities, NGOs and Mexican and US researchers, indicates high seabird bycatch. Interactions of seabirds with fishing gear have resulted in seabird death, injury, and plumage impregnated with fish oil. Birds with oiled plumage die within minutes or days, due to the fact that birds with oiled plumage lack the ability to thermo-regulate, keep isolated from water, and fly. The smallest amount of oil on the water surface is absorbed by the plumage, drastically altering its microstructure, resulting in the loss of these abilities and, eventually, death. In a period of 17 months of onboard observations, it was estimated that the highest effects, from among the 18 seabird species affected by the incidental catch during fishing operations, are experienced by the Brown Pelican (*Pelecanus occidentalis*), with an estimated 19,430 individuals, followed by the Blue-footed Booby (*Sula nebouxii*) with 3,083 individuals, and the Brown Booby (*S. leucogaster*) with 1,927 individuals. Effect varies with date and fishing zone. The two former species are under protection by Mexican law (NOM-059-ECOL-SEMARNAT). These mortality rates threaten the populations of these seabird species which nest on islands within the fishing area. Mitigation procedures to substantially reduce or preferably eliminate this bycatch need to be implemented.

## CONSERVATION NEEDS IN NORTHWESTERN MEXICO: THE SEABIRDS' ISSUE.

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While seabird conservation in the mid twentieth century in the Gulf of California was mostly related to human disturbance in nesting islands: human presence in or close to the nesting colonies, egg collection and introduced predators, at present it is reaching a critical point, where most of the issues are related to climate change, which affects seabirds' food availability, combined with fisheries which act in two ways: Indirectly by affecting food abundance, and directly by capturing seabirds as bycatch, mostly in purse-seine nets of the fleet. This fleet operates mostly between parallels 25°N and 30°N, along both coasts of the gulf. While studying seabird breeding and feeding ecology between 1980 to present in Isla Rasa, one of the main seabird nesting islands in the Midriff Region, we have observed that warm oceanographic anomalies (>1.0°C), may decrease fish availability and hamper nesting success. Since the turn of the century these anomalies have become more frequent and more localized. Seabird breeding success is also negatively affected by reduction in the sardine population, its best food source, as a result of intensive fishing by the industrial fleet, which has experienced several collapses since 1992, all of them related to ocean warm anomalies, but exacerbating the crisis of food reduction for seabirds and other ecosystem components. Finally, intense activity of the sardine purse-seine fishing fleet causes direct and indirect mortality of 18 seabird species through bycatch, including several dozens of thousands of individuals per year. Due to the severe changes induced by the anomalies, a precautionary approach to fisheries must be taken if we want to maintain a sustainable ecosystem in the gulf.

A DECADE OF COMMUNITY-BASED SCIENCE AND OUTREACH IN CALIFORNIA LEAST TERN  
CONSERVATION, LOS ANGELES COUNTY, CALIFORNIA

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Los Angeles Audubon collaborated with project biologists, management agencies, and other local Audubon chapters in conservation activities for California Least Terns (*Sternula antillarum browni*) in Los Angeles County, California, from 2007 through 2017. Most beaches in this county are backed by highly urbanized settings and receive millions of visitors annually, presenting considerable and on-going challenges to species conservation. To help address this, we recruited, trained, and coordinated volunteers to monitor California Least Tern nesting colonies, and we conducted a range of outreach activities. Projects goals were to (1) annually establish a team of volunteer monitors that could (a) increase data collection capacity for a project staffed by only a few biologists and (b) serve as docents for the public at nest sites; (2) use community-based science as a way to inform the public about and promote tern conservation; (3) provide public school students with cross-curricular opportunities to study tern conservation and produce products that could be used in conservation efforts. This combination of community-based science and public school outreach has allowed us to connect with a broad range of the public, including experienced birders, early career conservation professionals, college students, public school children from the Los Angeles urban core, local beach communities, and corporate employees. Additionally, volunteer monitors have consistently provided project biologists with standardized observations of nest colony attendance, tern behavior, and daily threats present at colonies. Public engagement has been an essential component to tern conservation along the Los Angeles coastline.



DISCOVERY AND MONITORING OF A NEW BREEDING COLONY OF *STERNULA LORATA* IN ILO, PERÚ.

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*Sternula lorata* is a species endemic to the Humboldt Current and is distributed from the Gulf of Guayaquil in Ecuador to Antofagasta, Chile. There are 4 known breeding sites in Perú located along the northern and central coast. From August 2016 to January 2017, we monitored a breeding colony of *S. lorata* found at Pampa El Palo, located in the Ilo district, in Moquegua state. The breeding colony covers ~600 ha and is a sandy open area with small shells. During monitoring, we recorded 8–324 adult terns, found 12 active nests with 1–2 eggs each, observed hatching in 3 nests, and recorded 101 fledglings. This last observation suggests that there were at least 50 nests. The nests that were found were located 18–70 m above sea level and 685–1,940 m from the coast. There was no indication of disturbance at any of the nests. There were nonetheless indications of anthropogenic and other threats such as passing motorized vehicles, local fishers, domestic dogs, and other natural predators. One of the primary components of the diet at the Pampa El Palo is the anchoveta (*Engraulis ringens*).

## BEHAVIORAL RESPONSES OF EASTERN BROWN PELICANS TO THE PASSAGE OF HURRICANE IRMA ALONG THE ATLANTIC COAST

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As highly mobile marine predators, seabirds are expected to modify their behavior in response to environmental stressors. While chronic stimuli such as climate may subtly or gradually influence distribution over months or years, acute environmental stressors such as storms are anticipated to alter behavior along daily or weekly timescales. Among the most disruptive of natural events, hurricanes have the potential to induce mortality at both individual and population levels. In September, 2017, Hurricane Irma made landfall as a major cyclonic event in southwestern Florida, USA, ultimately impacting much of the southeast Atlantic coast. We examined the movements of Eastern brown pelicans (*Pelecanus occidentalis carolinensis*) previously tagged at breeding colonies in South Carolina with GPS satellite transmitters to determine behavioral responses to hurricane passage. Using Expectation Maximization Binary Clustering and multinomial logistic regression, we found that pelicans were more likely to remain in a resting state versus an active state during periods of low barometric pressure and high wind speeds. In addition, tracks indicated that individual pelicans preferred to shelter behind coastal islands and in estuarine systems during hurricane passage rather than attempt to relocate from the storm or remain in oceanic habitats. We posit that the observed sedentary pelican response may be an intrinsic function, given their large size and coastal habitats. In contrast, smaller or more pelagic species may either utilize different strategies for managing large storm events, such as avoidance, or face more severe fitness risks such as stranding.

## POTENTIAL INTERACTION ANALYSIS OF OFFSHORE WIND ENERGY AREAS AND BREEDING AVIAN SPECIES ON THE US ATLANTIC COAST

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Due to increasing US interest in developing wind energy sites in offshore waters, we aim to synthesize existing data on colonial breeding seabird populations with the potential risk of interacting with lease areas. Previous efforts by BOEM and NOAA have synthesized distribution of species using at-sea survey data, and our effort seeks to complement this work by focusing specifically on birds during the critical and energetically-demanding breeding life history stage. Colonial information has been collected on numerous seabird species and combined via USGS's Colonial Waterbird Database. Foraging ranges, preferably during their breeding season, of each of the included species were determined through the scientific literature. Colony size and location for each species along the US Atlantic Coast from Massachusetts to North Carolina were integrated with buffers around the colonies that correlate with the species' foraging range. Species richness across foraging ranges, population-level sensitivity and other metrics will be calculated and overlaid onto BOEM lease areas. Furthermore, we collected GPS location data on a specific common tern (*Sterna hirundo*) population during their nesting season at Dawson Shoals, VA last year. By using miniaturized GPS transmitters, this project will be one of the first to utilize tracking data to create spatially-explicit collision and disturbance risk models to be expanded to include several seabird populations in the region. Animal movement and behavior along with animal distribution analyses will be conducted to develop these models. By conducting analyses using survey data and analyses using satellite telemetry data, we will be able to determine if traditional risk models are overestimating the potential impacts of offshore wind development on seabirds. This work will provide insight into minimizing collision and displacement of seabirds while developing an offshore wind energy industry in Virginia that will stimulate economic and job growth along with enhancing human and ecosystem health.

AN ALTERNATE METHOD FOR ESTIMATING FLEDGLING RATES FOR CALIFORNIA LEAST TERNS  
(*STERNULA ANTILLARUM BROWNI*)

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Fledgling numbers are notoriously difficult to determine for California Least Terns (*Sternula antillarum browni*), especially in large populations, because of the mobility of chicks soon after hatching and the difficulty of finding signs of predation. We compared two methods for estimating fledging rates: sub-sampling by using small enclosures coupled with banding, versus traditional visual counts of the entire population. The enclosures were 40 x 40 m, 60 x 60 m, or 60 x 90 m and were constructed with mesh plastic fencing 15-20 cm high, and erected before the nesting season. After trialing the enclosures for multiple years and comparing these estimates with the results from traditional visual surveys, the estimates from the enclosures were more accurate. The traditional visual counts can be biased and inconsistent year-to-year, whereas the enclosures help standardize data collection and improve confidence resulting in much more robust and accurate fledgling estimates. A critical component of the enclosure design was the requirement to be large enough to encompass a sufficient number of nests. In addition to obtaining information on yearly chick survival, growth data was also collected which can be used across years to investigate factors influencing growth and survival.

MIGRATORY MOVEMENTS AND LAND-DEPENDENT HABITAT USE OF BROWN BOOBIES *SULA LEUCOGASTER* DURING THE NON-BREEDING PERIOD

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Acknowledging the availability of geolocators (GLS), our understanding of seabird migration has been forward. Meanwhile, to date, behaviour during the non-breeding period is comparatively scarce in tropical seabirds, although studies on their foraging behaviour have been increasing during the breeding period. In this study, we examined migratory movements and activity patterns of Brown Booby *Sula leucogaster*, breeding on Nakanokamishima Island (Ryukyu Japan), during the non-breeding period using GLS in 2009–2015, including 5 individuals tracked for multiple years. Boobies spent their non-breeding in the Western Pacific at large scale, but exhibited the comparative variations in wintering habitat at individual level. The shortest direct maximum distance from the colony varied between individuals from 574–4988 km, showing the distance of 6575 km apart between the northernmost and southernmost wintering destinations as some birds travelled even towards north. Such the migratory movement patterns were broadly the same within individuals over years. During the non-breeding period, boobies spent  $11.1 \pm 8.2\%$  of time on water and the proportion of continuous dry period (i.e. out of water) remarkably increased in nighttime, even when they were no more engaged in a specific island as during the breeding period. Such the activity patterns at night may indicate their resting on land relating to an anti-predatory behaviour as *Sula* species including Brown Booby are sometimes attacked by sharks from underwater. Our results revealed high individuality in the migratory movement of Brown Booby and their land-dependent habitat use during the non-breeding period.

## EFFECT OF PARENTAL AGE AND TELOMERE LENGTH ON OFFSPRING RECRUITMENT IN BLUE-FOOTED BOOBIES (*SULA NEBOUXII*)

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Telomere dynamics are increasingly used as an indicator of individual quality in ecological systems. Because they are often related to chronological age, some effects previously attributed to chronological age may in fact be more closely associated with telomere length. In the blue-footed booby (*Sula nebouxii*, hereafter booby), a long-lived tropical seabird, offspring survival has been linked to the interaction of parental ages. Boobies do not mate assortatively by age and have a high divorce rate, so pairs of all age combinations are possible. Based on a large long-term dataset, offspring had the highest probability of recruitment when they came from nests with differently-aged parents: one old (> 13 yrs. old) and one young (< 8 yrs. old). Here we used quantitative PCR to measure telomere length in a subset of booby families breeding in 2011, and predicted that we would find a similar relationship between telomere length and offspring survival. Parental age did not explain offspring recruitment in this smaller dataset, but telomere length was strongly associated with recruitment. In a manner that mimics the chronological age findings, offspring recruitment was highest when parental telomere lengths were most different (one short, one long). Telomeres are weakly (but significantly) associated with age in this species, so this strong influence of telomere length on offspring survival may explain the effect of chronological age in a larger dataset. Telomere length was not related to parental survival (over six years), so the effect of this quality indicator appears to be functioning inter-generationally rather than on the individual in this species, with an interactive effect on fitness.

## HETERO-SPECIFIC GROUP FORAGING IN PYGOSELIS PENGUINS AT KING GEORGE ISLAND, ANTARCTICA

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Group foraging brings advantages for prey searching and catching, especially when the food source is heterogeneously distributed. Penguins are highly dependent on krill, which often form large swarms. Thus, penguin individuals can increase foraging efficiency in groups. Using animal-borne cameras on 23 gentoo penguins (*Pygoscelis papua*) and 24 chinstrap penguins (*Pygoscelis antarctica*), we recorded their foraging behavior during chick guarding in two breeding seasons (2014-2015 and 2015-2016). We found that *Pygoscelis* penguins, gentoo, and chinstrap penguins often form hetero-specific foraging groups. In five gentoo penguin videos, Adélie (*Pygoscelis adeliae*) or chinstrap penguins were observed in the foraging groups (totally 18 cases). In four chinstrap penguin videos, gentoo penguins were observed in the foraging groups (totally 7 cases). We did not observe any aggressive behavior towards different species in the groups. Our results suggest that *Pygoscelis* penguins in our population have hetero-specific group foraging strategies.

## SARDINE FISHERY INDUSTRY IN THE SOUTHERN GULF OF CALIFORNIA: DEVELOPMENT OF A RESPONSIBLE FISHERY

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Maz Sardinia S.A. of C.V. is a Mexican company founded in 1997 that is dedicated to small pelagic fishing, mainly the thread herring (*Opisthonema* spp.). It currently owns nine sardine vessels and is under the umbrella of the PINSA group. It is a company committed to the welfare of the environment and the conservation of fishing resources. For this reason, in 2012, Maz Sardinia joined with INAPESCA to undertake a program of observers on board and in 2013 started the pre-assessment process of the fishery, joining the world of sustainable fisheries. In October 2016 they became one of the first companies to obtain the Marine Stewardship Council (MSC) certification in Mexico thus gaining the global recognition of being a sustainable fishery. The company has evolved throughout the certification process, making continuous improvements in its fishing practices to reinforce the care of incidental species that are related to sardine fishing in the southern Gulf of California, including marine mammals, seabirds, turtles, sharks, rays and other fish species.



## COASTAL MOVEMENTS OF BREEDING MAGNIFICENT FRIGATEBIRDS FROM NORTHERN PERU

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Magnificent frigatebirds (*Fregata magnificens*) breed in the tropical mangroves of northern Peru. We used GPS loggers and analysis of spontaneous regurgitations to track the movements and determine the diet composition of breeding frigatebirds to examine possible interactions with fishing activities along the northern coast of Peru. Mean feeding trip duration was 14 h (0.6 – 70 h, n = 102). Birds flew predominantly south of the colony and along the coastline for a maximum distance of 166 km. They visited and stayed in or around fishing ports for several hours. Total distance traveled during their feeding trips ranged from 20 to 942 km. Some birds flew over land to shorten foraging distances. Birds preyed upon 19 species of fish, but 72% of the total number of items were represented by 5 demersal species that are part of the local artisanal fishery bycatch. Foraging movements of breeding magnificent frigatebirds in Peru were strongly linked to local inshore fishing activities. New fishing policies and restriction of trawling in northern Peru is beneficial to preserve the tropical marine ecosystem, but may be unfavorable for frigatebirds.

## USE OF UNMANNED AERIAL VEHICLES TO ESTIMATE GUANO BIRD NUMBERS OFF PERU

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Unmanned Aerial Vehicles (UAVs) or drones are increasingly used to determine numbers of colonial seabirds because their use in some species may decrease bird disturbance and increase count accuracy in comparison to other methods. In this study, we used UAVs on cormorant, booby and pelican colonies on 11 guano islands off Peru to: 1) test their efficiency to estimate colony sizes 2) evaluate possible adverse effects on the birds and 3) examine variables that may affect count accuracy. Semi-automatic counts from aerial photographs had a count error of < 10% (in comparison to controls) and were 4-5 times more accurate than other four sketching count methods. Flight altitude and speed approach of UAVs (both vertical and horizontal) had a minimal impact on bird behavior. No birds reacted to the drone presence at altitude > 50 m. The reaction to flight speed (0.5 - 15 m/s) was ambiguous, but the occurrence of disturbance was usually < 30% of the trials. Count accuracy was inversely correlated to the altitude where the photo was taken, particularly at flight altitude > 80 m. Likewise, bird density and number changed with reproductive condition and species. Counts of breeding birds were more accurate than those of non-breeding birds. The use of UAVs on the guano islands off Peru will significantly increase bird count accuracy, reduce logistic costs and decrease bird disturbance.

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