

PSG 2014 Juneau Abstracts

CHANGES IN SEABIRD FLIGHT BEHAVIOR WITH ALTERED WIND STRENGTH AND DIRECTION

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We analyze data from 114 cruises in which flight behavior and flight height of seabirds were recorded, in conjunction with wind speed and relative direction; cruises spanned the Southern Ocean, Peru Current, California Current and Equatorial Pacific, 1976 and 2006. The database includes over 250 seabird species, of which we used 104, selected based on an adequate number of observations for statistical analyses. We confirmed the hypothesis that groups of species would become evident based on degree of divergence in morphology from Pennycuik's "standard seabird," with the groups evident among and within flappers, glide flappers, and flap-gliders. Gliders, sea-anchor soarers and soarers were homogeneous in respective style. Seabird flight height and behavior changed as a function of wind speed and relative direction to travel. Flappers flew lower moving into as opposed to with the wind; sea-anchor soarers showed little response to changing wind speed; and soarers flew high. Otherwise, glide-flappers, flap-gliders, and gliders generally increase flight height with wind speed, depending on relative wind direction (cross, into, following). We also confirmed the hypothesis that flight behavior and height would also be grouped in accordance with morphology, and that species' niches might be sorted by flight behavior, similar to how they often sort by bill size in their acquisition of food. Most of the glide-flappers, flap-gliders, and gliders would be highly vulnerable to offshore wind generating facilities, their flight heights bringing them well within the blade-swept zone of turbines. Flight behavior remains an underappreciated aspect of seabird natural history.

SEABIRD COLONIES RESTORATION IN THE MEXICAN PACIFIC ISLANDS OFF BAJA CALIFORNIA

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We present the results of the first year of systematic seabird monitoring in the Baja California Pacific islands. Fieldwork activities were carried out on Coronado, Todos Santos, San Martín, San Jerónimo, Natividad, San Roque and Asunción Islands. This is the first time all these islands are monitored simultaneously, giving us a clearer figure of the seabird populations at a regional scale. Coronado presented the larger species richness of the northern islands, with 21 species compared to 15 in Todos Santos. Of the southern Islands San Roque had the higher species richness, with 32 species, followed by Asunción and San Jerónimo with 26 species each,

Natividad 20 species and San Martín 18 species. The overall most abundant species was Brandt's cormorant (*Phalacrocorax penicillatus*), with 30000 individuals present, followed by Western gulls (*Larus occidentalis*) with 22000 individuals, Brown pelican (*Pelecanus occidentalis*) with 8000 individuals and Double-crested cormorant (*Phalacrocorax auritus*) with 6500 individuals. We are also conducting invasive vegetation control, in order to increase the area available for seabirds' habitat. So far we have removed invasive vegetation from 7 ha in Todos Santos and 6.5 ha from Coronado islands. To avoid burrows being trampled by people walking to the lighthouse on San Jerónimo, we are installing walkboards. A complementary environmental education program has also been launched, in collaboration with fishermen coops. This project is supported by the Montrose Settlements and Luckenbach Restoration Plans, the National Commission of Natural Protected Areas from the Mexican Government, and the in-kind collaboration of the Mexican Navy (SEMAR).

SAVING NEWELL'S SHEARWATERS-35 YEARS OF REHABILITATION AND RELEASE ON KAUA'I

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The Save Our Shearwaters Program was initiated by the State of Hawai'i in 1978 as a collection and release program for the thousands of threatened Newell's Shearwaters (*Puffinus newelli*) that were grounded on the island during fledging season. The phenomenon known as "fallout" occurs when fledglings leave their burrows in the interior of the island at night and overfly human populated areas on their first flight out to sea. As they pass over coastal areas, they become attracted to artificial light sources, which they then circle until they become exhausted and fall to the ground. Once grounded, the birds are easy prey for cats and dogs and can be struck by vehicles. In a great example of citizen conservation, members of the public collect the birds and put them in special boxes located at fire stations and other key areas. The birds are then collected by the Save Our Shearwaters program and taken in for rehabilitation and release. The program also handles other endangered seabirds such as Hawaiian Petrels (*Pterodroma sandwichensis*) and Band-rumped Storm-Petrels (*Oceanodroma castro*). The program has greatly increased in size and specialization over the years as staff fine-tunes the rehabilitation aspect of the program using internationally recognized "best practices" in wildlife rehabilitation. Such a long-running data set has also highlighted the on-going plight of the Newell's Shearwater, as numbers of fallout fledglings have decreased dramatically from a high of 2236 in 1987 to only 169 in 2012 (mirroring the trend outlined in other indices). The dramatic decline of this species stresses the continued importance of wildlife rehabilitation as a vital tool in the conservation of endangered seabirds on Kaua'i.

DERELICT GILLNETS IN THE SALISH SEA: CAUSES OF GILLNET LOSS, EXTENT OF ACCUMULATION AND DEVELOPMENT OF A PREDICTIVE TRANSBOUNDARY MODEL

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From 2002 through the end of 2012, a total of 4,358 derelict nets were removed from the Washington waters of the Salish Sea (WASS), 95% of which were gillnets. I investigated the causes and rates of gillnet loss from the WASS commercial salmon fishery through interviews with fishers and industry professionals and analysis of historical fishing effort. Major causes of gillnet loss included lack of experience, operator error, equipment malfunction, overcrowding of fishing grounds, mismatch of net depth with ocean depth, and more. The findings suggest that gillnet loss is currently much less frequent than in previous decades characterized by heavy fishing effort. Analysis of net removal records identified patterns of association between net fishing depths and depths at which derelict nets are found. Spatial analysis and ArcGIS were used to produce a simple model capable of identifying areas of high, moderate and low probability of derelict gillnet occurrence. This model was applied to the British Columbia waters of the Salish Sea (BCSS) where organized derelict fishing gear removal operations have not yet been implemented. This study refines previous estimates of derelict gillnet quantities in the WASS, identifies the major causes for derelict gillnet loss and produces an exportable model that can be used to assist the design and implementation of derelict fishing gear operations in British Columbia and beyond. Plans are underway to conduct derelict net surveys and removals in specific locations of the BCSS in 2014, and in turn, test the accuracy of the model reported here.

CONSTRUCTION EFFECTS AND VIDEO RESULTS FOR HAWAIIAN PETRELS

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Parking lot and road rehabilitation occurred directly adjacent to endangered *Pterodroma sandwichensis* (Hawaiian petrel, 'ua'u) nests at Haleakala National Park during peak nesting season. Biologists monitored nests with 24 hour video monitoring and sound recordings. Results this and past constructions events on nesting Hawaiian petrels will be presented. Other results of video monitoring, including predator effects, will be presented.

CAUSES OF SEABIRD MORTALITY IN THE IMMEDIATE AFTERMATH OF THE RENA OIL SPILL, BAY OF PLENTY, NEW ZEALAND

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The CV Rena ran aground on the Astrolabe Reef, 22 km off the Tauranga coast (Bay of Plenty, New Zealand), on 5 October 2011. The resulting spill of c.350 tonnes of heavy fuel oil over the following 6 weeks caused the largest oiled wildlife incident in New Zealand history, and triggered a large and complex oiled wildlife response. We summarise information obtained from over 2000 dead birds handled following the Rena oil spill. Over 1350 oiled seabirds of 29 species were recovered dead. The main species affected (with the number of oiled individuals recovered dead) were common diving petrel (*Pelecanoides urinatrix*; 703), fluttering shearwater (*Puffinus gavia*; 240), Buller's shearwater (*Puffinus bulleri*; 156), little penguin (*Eudyptula minor*; 90), white-faced storm petrel (*Pelagodroma marina*; 51), sooty shearwater (*Puffinus griseus*; 40), and little shearwater (*Puffinus assimilis*; 20). None of these species is listed as Threatened under the New Zealand threat classification system, but all seven taxa are listed as At Risk.

Common seabirds of the Bay of Plenty inshore waters that were not recovered in large numbers both visibly oiled and dead included grey-faced petrel (*Pterodroma macroptera gouldi*; 2), flesh-footed shearwater (*Puffinus carneipes*; 5), Australasian gannet (*Sula serrator*; 4), pied shag (*Phalacrocorax varius*; 3); little shag (*Phalacrocorax melanoleucos*; 0), southern black-backed gull (*Larus dominicanus*; 2), red-billed gull (*Larus novaehollandiae scopulinus*; 2) and white-fronted tern (*Sterna striata*; 0). Many of the non-oiled individuals had identifiable causes of death, including noteworthy fisheries-related mortality.

SILENT STRESSORS REVISITED: EVALUATING CADMIUM, MERCURY, AND SELENIUM IN PACIFIC SCOTERS

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Over the last 30 to 50 years, Pacific scoter populations have declined by an estimated 60%. We investigated liver and kidney metals concentrations and body condition of surf scoters (*Melanitta perspicillata*) and white-winged scoters (*Melanitta fusca*), and contrasted contaminant exposure during molt in heavily industrialized sites in the Puget Sound-Georgia Basin versus non-industrialized sites along the coast of southeast Alaska. In blood samples collected in 2009,

mercury and cadmium were significantly higher in industrialized sites than in non-industrialized sites. However, levels of selenium tended to be higher in southeast Alaska. Analysis of liver and kidney samples collected in 2005-06 showed that body condition in surf scoters declines as body burdens of cadmium, mercury, and selenium increase, and that white-winged scoters appear not to be as sensitive to inorganic contaminant exposure - particularly to selenium. Furthermore, we found that surf scoters maintain greater body mass in the winter, when they tend to feed primarily on invertebrates, than they do in early spring, when they make a marked shift from invertebrates to herring spawn as a primary food source. Our study also supports prior findings that selenium behaves differently than heavy metals and can be found in higher concentrations in saline environments than in brackish or freshwater aquatic systems. Although these data cannot distinguish point sources for metals exposure, they do inform our understanding of metals concentrations in Pacific scoters, and suggest that inorganic contaminants should be considered in addition to the array of other factors in assessing habitat quality for these birds.

REVIEW OF GILLNET FISHERIES EFFORT AND SEABIRD BYCATCH IN BRITISH COLUMBIA, CANADA: 1951-2007

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We review gill net fishing effort from 1951- 2007 in British Columbia and report on seabird entanglement rates as recorded by fishery observers (1995-2007). Fishing effort declined significantly over the time period. Observer coverage was often absent in commercial fisheries and never exceeded 5%. Test fisheries had better observer coverage, although the observers were focused on salmonid species identification rather than reporting of entangled birds. The most frequently entangled birds were Common Murre (*Uria aalge*) in fall and Rhinoceros Auklet (*Cerorhinca monocerata*) in summer. Marbled Murrelets (*Brachyramphus marmoratus*) were also captured in summer at a lower intensity. At the level of the set, the distributions of bird captures (birds/net hour) was highly skewed. The log transformed data will be analyzed to yield estimates of central tendency then back transformed to give estimates of bycatch rates. We conservatively estimate bycatch rates in fisheries with no observer coverage using our estimates based upon known fishing effort. We discuss the utility of additional data from beached bird surveys, and reports of birds found floating dead on estimates of bycatch. In recent years the Department of Fisheries and Oceans Canada has moved away from observing and has transferred those responsibilities to fishers.

COMPARISON OF CORMORANT DIETS IN TWO OREGON ESTUARIES

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We compared the diet of double-crested cormorants in the Columbia River estuary (CRE), the location of the largest breeding colony in western North America (~15,000 nesting pairs), to that of cormorants from Tillamook Bay (TB), a smaller estuary located 80 km to the south, during the 2012 breeding season. Stomach contents of birds collected in the CRE (n = 57) and TB (n = 40) were identified to the lowest taxon possible. The mass of each taxon was converted to energy using previously published energy density values and grouped into one of three categories: high-quality (>5 kJ/g wet mass), including clupeids, osmerids, and engraulids; medium-quality (4 to 5 kJ/g), including pleuronectids, embiotocids, and salmonids; and low-quality (<4 kJ/g) including gadids, cottids, and sebastids. Most of the energy/sample was from medium-quality fish from both the CRE (mean = 72.3%) and TB (mean = 73.0%). The average proportion of energy from high-quality prey in the diet of cormorants was more than 3x higher in the CRE (mean = 27.7%) than in TB (mean = 9.1%). The average proportion of energy from low-quality fish was 0.04% in cormorants from the CRE and 18.2% in cormorants from TB. These results suggest that the higher availability of high-quality prey, though a relatively minor portion of the diet, may contribute to both the extraordinary number and reproductive success of double-crested cormorants nesting in the Columbia River estuary.

BY-CATCH OF KITTLITZ'S MURRELET (*BRACHYRAMPHUS BREVIROSTRIS*) IN COMMERCIAL SALMON GILLNET FISHERIES IN THE GULF OF ALASKA: A RISK ASSESSMENT

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Bycatch of Kittlitz's murrelets (*Brachyramphus brevirostris*) in commercial gillnet fisheries is frequently cited as a conservation concern for this species, but there are few data on KIMU mortality in gillnets. We assessed the qualitative risk of KIMU bycatch in commercial salmon gillnet fisheries by evaluating the spatial and temporal overlap of KIMU and gillnets in 4 study areas where these fisheries have been monitored by the Alaska Marine Mammal Observation Program (AMMOP): Prince William Sound, Cook Inlet, Kodiak, and Yakutat. We used permit-days, the number of gillnet permit holders who reported catching fish on a given day in a given statistical area, as an index of fishing effort. We used existing KIMU survey data to plot KIMU

locations relative to fishing effort and identify areas with the greatest potential for fishery interactions. Temporal overlap was high; in all areas except Yakutat both the set and drift gillnet fisheries peaked in late June or July, when Kittlitz's murrelet abundance also peaks. There were localized areas of spatial overlap in all 4 study areas, although in general these were not the areas with the highest fishing effort. Areas at greatest risk for gillnet mortality include Alitak Bay in Kodiak and Manby Shore in Yakutat Bay. KIMU in these areas frequented the lower reaches of the bay, where gillnets also are typically concentrated.

SEX-SPECIFIC, SEASONAL FORAGING BEHAVIOR BY A MONOMORPHIC SEABIRD

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Using time-depth recorders and isotope analysis we investigate the habitat use and foraging behaviour of Common murre *Uria aalge* during three phases of the annual cycle characterized by sex-specific variation in the extent and nature of parental care, including breeding (bi-parental care), post-breeding (male-care only at sea) and winter when both sexes are equally independent of any reproductive constraints. During chick rearing, $\delta^{15}\text{N}$ values overlapped with no observed sex differences in the timing of foraging, diving tactics (dive depth, duration) or daily foraging effort (total minutes/day > 3m). During post-breeding, $\delta^{15}\text{N}$ values of both sexes decreased from chick-rearing in a similar manner and core foraging areas overlapped (50% kernels). Males had a significantly higher daily rate of diving (106.8 ± 58.1) than females (53.3 ± 27.7), with more than double the time spent foraging per day (176.8 ± 104.0) relative to females (75.0 ± 42.6) and also dove significantly deeper ($p=0.003$) than females. In winter, the $\delta^{15}\text{N}$ values of both sexes increased similarly, and core foraging areas overlapped. The daily foraging time of males decreased from post-breeding (92.6 ± 79.9) but increased for females (112.4 ± 65.4), resulting in significantly higher daily foraging time for females in winter. Both sexes dove frequently at night (29% and 25% respectively for males and females), and males had a significantly higher frequency of shallow (<40m) dives (50.5%) relative to females (29.3%). We demonstrate that male-only care at sea represents a significant investment and that sex-specific foraging patterns during winter may reflect the need for males to recoup energy expenditures involved with chick provisioning at sea.

SUCCESS IN RESTORATION OF A BREEDING COLONY OF THE CHINESE CRESTED TERN IN THE JIUSHAN ISLANDS, ZHEJIANG PROVINCE, CHINA

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The Chinese Crested Tern (*Sterna bernsteini*), a Critically Endangered seabird with an estimated population no exceeding 50 birds, deserted the breeding ground in the Jiushan Islands in 2008 because of human persecution. In 2013 we used decoys and playback system and successfully attracted more than 2,600 Greater Crested Terns and 19 Chinese Crested Terns to the Jiushan Islands. More than 600 Greater Crested Terns and at least one Chinese Crested Tern fledged the site in early October.

SEABIRD BYCATCH BY GILLNET FISHERIES IN THE REPUBLIC OF KOREA: A PRELIMINARY REPORT FROM THE KOREAN WILD BIRDS SOCIETY

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Bycatch in fisheries is one of the main causes of global seabird declines. Although mass mortality of seabirds by gillnet fisheries has long been known worldwide, the current status in NE Asia is unknown except in the Russian EEZ. The Korean Wild Birds Society, a non-profit NGO in the Republic of Korea, has voluntarily conducted seabird bycatch surveys since 2008/9 in Gangwon Province, the north-eastern part of South Korea. Volunteers visited 22 harbors once per month from December to February to search for dead seabirds left in fishing vessels, abandoned nets, and garbage cans. According to the six independent counts from 11 harbors in Goseong County (four winter counts) and 11 in Sokcho City (two winter counts), a total of 2,545 birds killed by gillnet fisheries were found (424.2 ± 296.9 birds). Ancient Murrelets (*Synthliboramphus antiquus*) were the most common victim (2,165 birds, 85.1%) followed by Black-throated Loons (*Gavia arctica*; 86, 3.4%), and Long-billed Murrelets (*Brachyramphus perdix*; 47, 1.8%). Although patterns of bycatch were spatiotemporally variable according to food availability and fishing activities, December was the most vulnerable season. Given the small number of fishing vessels in the survey areas, the high removal rate and the prolonged bycatch throughout the whole wintering period, simple statistics suggest that the annual number of seabird bycatch may exceed 5,000 birds in Gangwon Province alone. Further investigations may enable us to produce a reliable estimate of the total annual bycatch and to develop a mitigation strategy for the conservation of wintering seabirds in Korea.

TOP-DOWN AND BOTTOM-UP INTERACTIONS INFLUENCE REPRODUCTIVE SUCCESS AT A CASPIAN TERN SUPER-COLONY

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The Caspian tern (*Hydroprogne caspia*) breeding colony on East Sand Island (ESI) in the Columbia River estuary, the largest colony of its kind in the world, experienced a decade of declining nesting success, culminating with the failure of the colony to produce any young in 2011. Since 2001 the decline in reproductive success of Caspian terns at ESI has been associated with a significant increase in average river discharge during May and June. We also found a significant increase in kleptoparasitism rates of terns by glaucous-winged/western gulls (*Larus glaucescens* x *L. occidentalis*) since 2001, and a significant negative relationship between average annual rates of gull kleptoparasitism and Caspian tern nesting success at ESI. There has also been a significant increase in disturbance rates by bald eagles (*Haliaeetus leucocephalus*) during June for terns nesting at the ESI colony, and eagle disturbance rates were positively associated with May river discharge. The abundance of forage fish for terns in the estuary was inversely related to river discharge, which also influences the reliance of tern nest predators on the tern colony as a food source, resulting in increased disturbance and decreased reproductive success at the tern colony. Although correlational, our results support the hypothesis that the decline in Caspian tern nesting success at this large estuarine colony is primarily initiated by bottom-up factors, both as they directly affect tern productivity through the food supply, and indirectly as they affect the alternative food supply of potential tern nest predators.

AN ATTEMPT TO PREVENT THE DISAPPEARANCE OF HAWAIIAN PETRELS (*PTERODROMA SANDWICHENSIS*) AND NEWELL'S SHEARWATERS (*PUFFINUS NEWELLI*) FROM WEST MAUI, HAWAII

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Addressing provisions of two HCPs, we implemented measures necessary to insure survival of endangered Hawaiian petrel (*Pterodroma sandwichensis*) and threatened Newell's shearwater (*Puffinus newelli*) populations on West Maui. Surveys indicate that both species are relegated to the extreme highlands and predation by introduced mammals is the leading cause of their continued decline. We developed population dynamic models to evaluate effects of predator

control and predict likely trajectories of each population under different management regimes. Results indicate positive population growth can only be achieved by establishing predator-free colonies. A site was selected in the West Maui foothills in proximity to an active but undisclosed Hawaiian petrel colony (aerial displaying apparent) that exhibited alarmingly high levels of mongoose activity. Newell's shearwaters have been observed vocalizing and flying through this area toward remote highland breeding sites where colony localization and subsequent management have proved cost-prohibitive and logistically infeasible. Predator-excluding fences were erected around two, roughly 4.25 acre sites; mongoose, feral cats, and rats have been removed; artificial nesting burrows have been installed. Call playbacks and custom-fabricated decoys will be used beginning February 2014 to attract prospecting birds to the sites. We present research that led to selection of the management site, modeled projections of success, project status, conservation merits of establishing predator-free breeding refugia for these ESA-listed seabirds in Hawaii, and the collaboration that has shaped the project and helped advance recovery objectives for Hawaiian petrels and Newell's shearwaters.

CROWD-SOURCING FOR CASPIAN TERNS AROUND THE WORLD

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We are interested in developing a global network for monitoring Caspian Terns (*Hydroprogne caspia*) because we believe they have particular value in understanding the role of climate change on species distributions given they are naturally among the world's most cosmopolitan species. In addition to reviewing the historical literature and compiling data collected by professional wildlife biologists we are evaluating the efficacy of crowd-sourced data to complement presence and absence data for Caspian Terns throughout their cosmopolitan range. We are especially interested in georeferenced images on photo-sharing sites like Flickr.com as the images allow us to validate the species of tern and include other types of data (e.g. habitat, diet, interspecific associations). In comparing our new records (n=856) of Caspian Tern at the continental level we were able to make a relatively large contribution to adding distributional information in Africa. We are exploring the value our data relative to other sources, especially those that contribute to the open data infrastructure of the Global Biodiversity Information Facility (www.gbif.org). Ultimately we are interested in creating a predictive habitat model that could be applied over the entire globe and have applicability in the conservation and management of this species during climate change.

MAGNETIC CLEANSING OF OILED SEABIRDS: WHERE ARE WE AND WHERE TO NEXT?

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Researchers at Victoria University and the Phillip Island Nature Parks, Australia have been working on advancing the rescue and rehabilitation of oiled wildlife using oil-sequestering magnetic particles for the removal of contaminants from plumage. This treatment has some advantages over conventional detergent-based methods including not requiring water, significantly less recovery time, being potentially useful on site as well as being faster and cheaper. Advances to date include establishing that the removal of oil using this treatment increases at warmer temperatures, with pre-conditioners and with particles engineered to increase magnetic particle surface area. We are currently testing to see if Little Penguins *Eudyptula minor* exposed to equivalent levels of magnetism as they would during a moderate cleaning process experience any disorientation. To date four pairs of control and experimental (magnetic exposure) birds have been satellite-tracked on one day trips and have not acted significantly differently. The next step, apart from designing a functional field cleaning unit, is to test the technique in the field at an oil spill. We want to test both the ease of cleaning and the effects of this technique on the water-proofing of the birds' plumage using thermal imaging.

REGIME CHANGE OFF NORTHERN ALASKA: SEABIRDS TRY TO REMAIN TEMPERATE AS THE ARCTIC BECOMES SUBARCTIC

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Oceanic and atmospheric oscillations that drive multi-year changes in marine ecosystems are now well known and, depending on the amount they affect commercial fisheries, well studied. These episodic regime shifts typically influence seabird populations through their effects on SST and resulting changes in prey availability and type. Oscillation states that negatively affect marine bird productivity are normally too short to result in any long-term consequences to seabirds in a region. However, recent climatic changes in the Arctic have caused a marine ecosystem shift that, unlike those in a short-term oscillation, is unlikely to revert to an earlier state in the near future. Moreover this appears to be just the initial shift in what could be a succession of changes in the Arctic's marine environment as the region and the planet continue to warm.

Black Guillemots (*Cephus grylle mandtii*) breeding in the western Beaufort Sea have recently experienced a change in prey availability and type in their summer foraging area. While in the

last half of the 20th Century late August sea ice remained well within 50 km of the breeding colony, with SSTs <1°C, during the last decade sea ice has frequently retreated >100 km and SSTs increased by 2°C during the period parent guillemots provision young. The resulting reduced availability of Arctic Cod (*Boreogadus saida*), the primary forage fish in the Arctic Basin, has decreased guillemot breeding success and quality. While guillemots are attempting to adjust to this recent regime shift, they, and other arctic seabirds, will need to continue to respond to major alterations in their marine environment in the near future, including the loss of summer sea ice.

WHAT WE JUST LEARNED AND WHAT MIGHT BE ON THE HORIZON: SEABIRD OBSERVATIONS FROM THE DECK OF THE TITANIC

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As PSG enters its fifth decade, researchers are using a range of technological tools to assess seabird movements, diet, diving behavior, genetics, hormones, etc. that were unimaginable during the first decade of PSG. Additionally, new statistical tools and a wealth of readily available datasets on physical and biological oceanography help greatly in the analysis and interpretation of data gathered by seabird biologists. Unfortunately these major enhancements to marine bird research come at a time when the number and magnitude of threats to marine ecosystems have never been larger, while at the same time agency ability to adequately address these threats declines.

This presentation, the first of its kind to be given at a PSG meeting, will seek to summarize the talks and posters presented in the previous three days, focusing on the more noteworthy findings, and most important themes. It will also include an attempt to identify future opportunities, challenges and difficulties in seabird research and conservation about which meeting attendees will be encouraged to share their thoughts in an open discussion.

FROM OVERLOOKED TO OVERWHELMED: ARCTIC ALASKA'S SEABIRDS AT THE CROSSROADS

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A number of factors differentiate Alaska's Arctic seabirds from those associated with subarctic waters south of the Bering Strait. Historically the seabirds inhabiting the Arctic Ocean off northern Alaska, and the marine ecosystems that support them, have received far less attention than those in the Bering Sea and Gulf of Alaska, as ice-covered seas and minimal commercial fishing in the Arctic reduced both the occurrence and need for biological oceanographic sampling.

The seabird community of the Alaskan arctic differs from the adjacent subarctic in both diversity and size due to a paucity of rocky headlands and lack of rocky islands to support cliff and cavity nesting species, coupled with lower levels of primary productivity resulting in lower prey densities and diversity. However, the Alaskan Chukchi and Beaufort seas are adjacent to extensive areas of tundra that support a diverse assemblage of loons, waterfowl, shorebirds and gulls that make extensive use of the adjacent marine habitats in late summer and early fall.

Interest in Alaska's Arctic seabirds has increased in the last decade as demand for the region's offshore oil has spurred government and industry sponsored research efforts in the region at the same time that all arctic marine resources are receiving increased attention due to threats associated with warming temperature. The potential for additional direct anthropogenic impacts is increasing as reduced ice makes the region more navigable allowing increased shipping increase and the potential for expanded commercial fisheries.

BIODIVERSITY, BIOMASS, AND ENERGY TRANSFER IN THE NORTH PACIFIC: INSIGHTS FROM 40 YEARS OF AT-SEA SEABIRD SURVEY DATA

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Biodiversity, biomass, and energy transfer are important conceptual metrics for understanding ecosystems. At-sea surveys of seabirds in the North Pacific have been conducted using similar protocols by numerous researchers for the last 4 decades. We used the North Pacific Pelagic Seabird Database (NPPSD) to identify patterns in biodiversity, biomass, and energy transfer across the northern Pacific Ocean and thereby provide insights into the ability of seabirds to reflect broad ecosystem status. Both species and broader taxonomic groupings were tested by binning them into 100k x 100k cells. Counts within each bin were divided by the total area

sampled within the bin. We tested these metrics with regressions using bathymetry and sea surface temperature, and satellite indices of annual primary productivity as well as identified spatial patterns and correlations between the biodiversity, biomass, and energy transfer metrics. We will demonstrate how these metrics reflect the interaction between broad-scale ecosystem components and seabird distributions, thus providing a better understanding of the complex factors driving these distributions.

INDIVIDUAL SPECIALIZATION OF ARCTIC SEABIRDS VIA FREQUENCY-DEPENDENT SELECTION

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Many populations of Arctic predators are made up of both individuals that consume a variety of prey items (“generalists”) and individuals that specialize on a small subset of the available prey items (“specialists”). Why are some individuals specialists and others generalists? One possibility is that one foraging mode (i.e. specializing vs. generalizing) may have lower fitness than the other, in which case that mode may be a secondary strategy that is used by lower-quality, possibly younger, individuals. Alternatively, specialists and generalists may have equivalent fitness, dependent on year-to-year availability in the prey field, leading to the evolutionary persistence of both strategies. To examine these ideas, we measured the diet and fitness of 161 thick-billed murre (*Uria lomvia*) over 20 years from 1993 to 2013. Roughly two-thirds of the population showed significant levels of specialization and the rest were considered generalists. Dive depth correlated with blood oxygen stores ($R^2 = 0.33$). Thus, specialization may be partly maintained because individual morphology (oxygen stores) is adapted to a particular foraging strategy. Energy delivery rates were correlated with chick growth rates and chick growth rates were correlated with recruitment. Although long-term fitness (offspring recruitment as inferred from energy delivery rates) was independent of foraging mode, specialists had higher fitness in years when generalists had a higher proportion of the prey item they specialized upon. We concluded that specialists and generalists were evolutionary stable strategies that were maintained by environmental variability in prey fields.

SEA DUCK TROPHIC ECOLOGY: A REVIEW OF BOTTOM-UP AND TOP-DOWN RELATIONSHIPS IN NEARSHORE MARINE SYSTEMS

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Bottom-up influences of oceanographic conditions and subsequent variation in prey quantity or quality are well-studied for pelagic seabirds. Similarly, top-down effects of seabirds on fish populations have been considered. There is a growing appreciation that these trophic relationships also can be important in nearshore food webs that include sea ducks and their invertebrate prey, with potential implications for sea duck demography and nearshore benthic community structure. We review emerging evidence on these themes and highlight areas where additional research is needed. Several recent studies have documented correlations between abundance of sea ducks and oceanic conditions, including broad-scale, long-term variation such as the PDO. Mechanisms underlying these relationships are not known, but variation in ocean conditions is known to have effects on performance of sea duck prey (e.g., bivalve recruitment, growth, or survival), which in turn has been linked at local scales to sea duck fitness. Contrasting this hypothesis with other putative causal mechanisms is a critical research need. Understanding these relationships may be critical for predicting how variation in ocean temperature, pH, freshwater and terrestrial inputs, or productivity radiate through nearshore ecosystems. Top-down effects of sea ducks on benthic prey abundance, size class, and community composition have been demonstrated at local scales in both rocky and soft-bottom habitats. The ubiquity of this effect and the importance of sea ducks as structuring agents in nearshore systems deserves additional consideration.

ENERGETICS OF BROWN PELICAN NESTLINGS

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Estimates of daily energy expenditure in young seabirds are sparse. Current energetics models for growing birds are largely based on species with precocial young that nest at high-latitudes. To improve this information gap, we measured daily energy expenditure (DEE) in altricial Brown Pelican (*Pelecanus occidentalis*) nestlings at a sub-tropical colony in Charleston County, South Carolina, USA. We also calculated growth rates of nestlings by taking body measurements every 3-4 days. To determine DEE, we sampled alpha and beta nestlings (n = 30) using the doubly labeled water (DLW) method during a phase of rapid body growth when young remain in the nest and are dependent on parental care. Nestling age ranged from 20-28 days and body mass ranged from 680-2300 g at the time of DLW sampling. DEE (range: 550 – 2776 kJ/day)

increased positively with growth rate ($p = 0.05$) but did not differ by nestling order or the interactive effect of these two factors ($p > 0.1$ for both). The presence of ectoparasites, which can positively relate to growth rates, did not appear to affect DEE or growth rates in this study ($p > 0.1$ for all). Growth rates of alpha nestlings, however, were greater than those of beta nestlings ($p < 0.01$), which suggests that younger nestlings may allocate a larger proportion of energy to activities, such as begging and aggression, than older siblings.

APPARENT SURVIVAL OF ADULT LEACH'S STORM-PETRELS (*OCEANODROMA LEUCORHOA*) BREEDING ON BON PORTAGE ISLAND, NOVA SCOTIA

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Populations of Leach's Storm-petrel (*Oceanodroma leucorhoa*; hereafter petrel), one of the most widespread tube-nosed seabirds in the world, appear to be declining considerably in parts of its breeding range. As part of a regional effort to assess status of petrel populations in eastern North America, we estimated apparent survival and recapture rates from 2009-2013 for adults on Bon Portage Island (43° 28' N, 65° 44' W), located off the southwestern coast of Nova Scotia. This ~1.5 km² island is recognized globally as an Important Bird Area, supporting roughly 50,000 pairs of petrels during the breeding season. Constant annual survival estimated for this colony is alarmingly low (0.61 ± 0.02), considering the long lifespan, low reproductive output and high site tenacity exhibited by this species.

Potential threats to petrels include predators, encounters with off-shore natural gas platforms, mercury contamination, and changing climatic conditions in both their breeding and wintering ranges. However, with only five years of data from Bon Portage, it is difficult to discern whether low apparent survival represents true mortality, or is an artifact of observer disturbance, or temporary or permanent emigration from the study plots or breeding colony. With additional years of recapture data, and insights gained from tracking studies, we will be able to investigate the relationship between appropriate climate indices (e.g., North Atlantic Oscillation) and adult survival of petrels at this colony, which may improve our understanding of what influences population dynamics of petrels, and similar species worldwide. This low survival rate is an early indication that this important colony may also be under stress.

PRELIMINARY ESTIMATES OF SEABIRD BYCATCH IN THE ALASKAN HALIBUT LONGLINE FISHERY IN 2013

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NOAA's Alaska Fisheries Science Center fisheries observers have been monitoring catch in Alaskan groundfish fisheries since the 1970's. Seabird bycatch information has been recorded in detail since 1993. Annual seabird bycatch estimates have provided valuable information for conservation and management. Throughout this period the halibut longline fishery was exempt from observer coverage. In 2012, after years of work by agency staff, the North Pacific Fisheries Management Council, industry, and environmental groups, the observer program was restructured. Beginning in 2013, observers have been deployed to halibut longline vessels. The standard seabird monitoring duties were carried through and data collection is currently underway. We report here the first year's results of seabird bycatch in the halibut fleet in Alaskan waters and contrast that against those of the groundfish longline fleets where, during the 2007-2011 reporting period, estimates of total bycatch ranged from 4,596 to 10,441 birds. Of particular interest is the take of Black-footed Albatross (*Phoebastria nigripes*) and Laysan Albatross (*Phoebastria immutabilis*) in longline fisheries, which averaged 154 and 200 birds per year respectively. The most common species taken in the groundfish fishery was Northern Fulmar (*Fulmaris glacialis*), averaging 4,241 per year (from 1,782 to 7,161 birds) and accounting for > 50% of the bycatch. The halibut fishery will be contrasted with the cod freezer longline fishery which had the highest total bycatch, and the sablefish fishery, which had lower bycatch numbers but tended to have higher albatross bycatch.

SEABIRDS ARE A LIFETIME STUDY

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Ecological studies tend to segregate into those that highlight spatial dimensions (biogeography, landscape ecology) and those that highlight changes over time. Seabirds, because they live a long time and because they often breed in dense aggregations, lend themselves especially to time-trend investigations. There are many long-term studies which have followed key ecological indicators of seabird biology over decades. I review some of these studies, with emphasis on two that I initiated myself (Ancient Murrelets in Haida Gwaii, Thick-billed Murres in Arctic Canada) and develop guidelines for what can be expected from such long-term studies. I contrast the investment required and the results that can be expected for different species and life-histories and consider whether there may be an optimal duration for such studies. In doing so, I discuss

whether long-term studies require annual replications, how big a sample size is required for meaningful estimation of survival rates, and why modeling populations based on measured demographic traits may not be very useful, except as a stimulus for further empirical work. In closing, I consider what significant questions remain relating to seabird demography and population change and how they can best be answered.

CHALLENGES ASSOCIATED WITH ERADICATING BLACK RATS FROM FORESTED ISLANDS IN BRITISH COLUMBIA AND LESSONS LEARNED FOR FUTURE ISLAND RESTORATION PROJECTS

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Haida Gwaii, an isolated island archipelago off the west coast of Canada, is renowned for its rugged coastline, temperate rainforest landscape and distinct flora and fauna that have evolved through 14,000 years of isolation from the mainland. Approximately 1.5 million seabirds from 13 species nest on the islands of Haida Gwaii including 50% of the global Ancient Murrelet population. Recently two areas within Gwaii Haanas National Park and Haida Heritage Site (located at the southern end of Haida Gwaii) were internationally designated as Important Bird Areas (IBAs), primarily to conserve seabird nesting sites. However, the introduction of rats to islands within the IBAs Haida Gwaii has led to the demise of several historic seabird nesting colonies, including that of the Ancient Murrelet. In September 2013, Parks Canada Agency, in partnerships with Coastal Conservation and Island Conservation implemented Canada's first aerial broadcast eradication of black rats from two islands within the Ramsay Island /North Juan Perez Sound IBA, where seabird colonies and ecosystem processes have been negatively impacted by this species. The eradication of black rats from Murchison and Faraday islands posed several challenges to the planning team, including the presence of a dense forest canopy (bait interception), the presence of introduced invasive Sitka black-tailed deer (a bait competitor), weather constraints, and a goal to minimize impacts to native species during the eradication, especially culturally significant species for the Haida First Nation. We present here a summary of these challenges and the measures that were implemented in order to address them.

AT-SEA SURVEYS REVEAL YEAR-ROUND DOVEKIE DISTRIBUTION IN THE WESTERN NORTH ATLANTIC

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Little is known about the at sea distribution of the Dovekie (*Alle alle*), the most abundant seabird in the North Atlantic, especially during the non-breeding season. To examine the year-round distribution of Dovekie, we collected data from 25 survey cruises conducted in 2013 from February through December, travelling offshore eastern Canada between 41 and 75 degrees north. We surveyed 7893 km² and encountered an estimated 12,339 Dovekie. Densities (adjusted for detectability) ranged from 3-943 birds/km², and were highest in the deep waters off the Grand Bank and Scotian Shelf in April, off the east coast of Baffin Island and in the Davis Strait in August and September, and on the Labrador Shelf in October. In general, our survey data show that large numbers of Dovekie wintered in offshore waters of Nova Scotia and Newfoundland, travelled across the Labrador Sea in spring to breeding colonies in Greenland, and were found in Baffin Bay and Davis Strait immediately post-breeding, when many of the birds observed were identified as juveniles in what was assumed to be family groups. Dovekie returned to Atlantic Canada waters in October and remained in relatively high densities through December. These data support recent tracking results from major Dovekie colonies on the west coast of Greenland. Unifying the results from at-sea surveys and tagging studies will provide more robust maps of distribution, and help ensure appropriate protection of Dovekies during periods when they inhabit these waters.

INTER-SEASONAL MOVEMENTS AND WINTERING AREAS OF ALEUTIAN TERNS

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In comparison to many migratory seabirds, essentially nothing is known about non-breeding migration and distribution of Aleutian terns, except anecdotal evidence that the species has been observed in Southeast Asia. We collated and will present the known information on migration and non-breeding areas from published notes and non-published records. We add to that information with data on the migration pattern, timing, and non-breeding locations of Aleutian Terns deployed with geolocators from Yakutat, AK. Data from the recaptured birds showed a one-way migration over 10,000 mi to and from Southeast Asia and Austral-Asia."

THE KAUAI SEABIRD HABITAT CONSERVATION PROGRAM: COMMUNITY SUPPORT AND ADAPTIVE MANAGEMENT CHALLENGES

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On the Island of Kauai, endangered and threatened seabirds have been harmed by artificial light attraction and collisions with utility lines for some three decades. Island-wide estimates suggest that hundreds of seabirds annually are downed from light disorientation and collide with structures, contributing to species population declines and presenting a situation with an inherent urgency to resolve. The Kauai Seabird Habitat Conservation Program (KSHCP) will provide a framework under which multiple non-federal entities may each receive separate federal and state permits for incidental take associated with lighting and utility structures in compliance with endangered species laws. Because entities would collectively fund conservation to offset impacts to the species, the development of long-term conservation partnerships with private and public entities in the community is critical to achieving the goals of the program. While strong community support exists for wildlife conservation and habitat conservation plans (HCP), the scientific uncertainties surrounding cumulative impacts and the feasibility of cost-effective mitigation creates planning challenges that highlight the importance of adaptive management. Part I of this presentation will explore challenges related to adaptive management components of the KSHCP. Part II will discuss ways to sustain community support in the context of these challenges and HCP voluntary participation.

REMOTE ACOUSTIC RECORDERS REVEAL THE IMPACT OF INVASIVE RATS ON NOCTURNAL BURROW-NESTING SEABIRDS IN HAIDA GWAI

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Haida Gwaii is home to 1.5 million nesting seabirds, including 50% of the global Ancient Murrelet population and significant portions of the global populations of other seabirds. Invasive rats pose a significant threat to the conservation of these populations. In 2010 Gwaii Haanas National Park Reserve and Haida Heritage Site initiated the Night Birds Returning project with the goal of eradicating invasive rats on a number of islands. We used automated acoustic recording units (ARUs) to explore the effect of invasive rats on the abundance and breeding phenology of nocturnal seabirds on Haida Gwaii. By examining and quantifying presence-absence of 4 nocturnal seabird species (Ancient Murrelets *Synthliboramphus antiquus*, Cassin's Auklets *Ptychoramphus aleuticus*, Fork-tailed Storm-Petrels *Oceanodroma furcata* and Leach's

Storm-Petrels *Oceanodroma leucorhoa*), we were able to assess the effect of rat disturbance, the spatio-temporal distribution of birds, and the extent of current breeding activity on rat versus rat-free islands. Our results showed a strong effect of rats on all species ($P < 0.001$). To achieve monitoring objectives, we calculated the odds of detecting seabirds on rat-free versus rat-infested islands, compared relative abundance, and determine the extent and continuity of colony attendance during the breeding season at rat versus non-rat islands. Perhaps most importantly, our results imply that at least some nocturnal seabirds are still attempting to breed on rat-infested islands, with the length of presence for some species similar between some rat versus non-rat islands. This suggests that passive seabird recovery is possible in a short time after rat eradication.

A BIOCHEMICAL APPROACH FOR IDENTIFYING PLASTICS EXPOSURE IN LIVE WILDLIFE

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Plastic pollution is a ubiquitous issue. Global use of plastics is increasing and there is an increasing interest in understanding the risk associated with plastics exposure to wildlife, particularly in the marine environment. To identify whether wildlife have ingested plastics, we developed a minimally invasive tool that allows for assessment of plastics exposure. Using a simple swabbing technique in which a waxy oil is expressed from the uropygial gland of birds, we successfully tested for presence of plasticizers (dimethyl, dibutyl and diethyl hydroxyl phthalates) in multiple seabird species. The three plasticisers for which we tested are prevalent in the manufacturing of plastic end-user items which often end up in the marine environment. Using gas chromatography and a detailed cleaning process to control for potential contamination issues, we were consistently able to detect targeted plasticizers. The method described has broad applicability for quantifying plastics exposure in wildlife at individual, population and species levels. Furthermore, the approach can be readily modified as needed to survey for plastics exposure in taxa other than seabirds and applying a simple, minimally invasive approach is particularly appealing as it has no observed detrimental impacts to wildlife. We present our results to date and applications relevant for this exciting new method.

A MULTIPLE MARKER APPROACH TO IDENTIFYING ORIGINS FOR UNKNOWN PROVENANCE SEABIRDS CAUGHT AS BY-CATCH IN FISHERIES

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An emerging issue in movement ecology is the ability to identify the natal site or colony of origin for individuals encountered away from their natal or breeding grounds. In particular, linking activities such as hunting or harvesting or fisheries bycatch with changes in population size to understand demographic or large-scale impacts of human activities has largely been an intractable problem and validation of certified sustainable fisheries is increasingly of interest. Applying a geographic assignment approach using a combination of data types (e.g. stable isotope, trace element, morphometric and/or genetic data, to assign taxa to their site of origin can allow researchers and managers to prioritize conservation approaches and establish appropriate mitigation or offset measures for impacted populations. We developed a population assignment approach and trialed it using eighteen stable isotopes and trace elements and twelve microsatellite markers to compare Flesh-footed shearwaters (*Puffinus carneipes*) from five breeding sites across their geographic range (N = 128) to 120 birds of unknown provenance killed via fishing activities. Our aim was to identify likely colonies of origin. Using a resampling procedure and ‘weighting the assignments’, we improved assignments of unknown provenance birds to nearly 70%. This new approach is widely applicable, utilizes a variety of disparate marker types and can be employed for a variety of seabird taxa where identifying geographic origin is the aim.

OCCUPANCY OF YELLOW-BILLED AND PACIFIC LOONS: EVIDENCE FOR INTERSPECIFIC COMPETITION AND HABITAT MEDIATED CO-OCCURRENCE

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Interspecific competition is an important process structuring ecological communities, however, it is difficult to observe in nature. We used an occupancy model approach to evaluate evidence of competition between yellow-billed (*Gavia adamsii*) and Pacific (*G. pacifica*) loons for nesting lakes on the Arctic Coastal Plain of Alaska. With multiple years of data and survey platforms, we estimated dynamic occupancy states (e.g., rates of colonization or extinction from individual lakes) and controlled for detection differences among aircraft platforms and ground survey crews. Results indicated that yellow-billed loons were strong competitors and negatively

influenced the occupancy of Pacific loons by excluding them from breeding lakes. Pacific loon occupancy was conditional on the presence of yellow-billed loons, with Pacific loons having almost a tenfold decrease in occupancy probability when yellow-billed loons were present and a threefold decrease in colonization probability when yellow-billed loons were present in the current or previous year. Yellow-billed and Pacific loons co-occurred less than expected by chance except on very large lakes or lakes with convoluted shorelines; variables which may decrease the cost of maintaining a territory in the presence of the other species. These results imply the existence of interspecific competition between yellow-billed and Pacific loons for nesting lakes; however, habitat characteristics which facilitate visual and spatial separation of territories can reduce competitive interactions and promote species co-occurrence.

SEABIRDS, OIL SPILL RESPONSE AND THE US FISH AND WILDLIFE SERVICE: DWH AND CHANGING MANAGEMENT PRIORITIES

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The April 20, 2010 Deepwater Horizon (DWH) drill rig explosion and oil spill in the Gulf of Mexico was the largest oil spill in US history. For weeks the nation anguished over the impact this spill would have on the rich ecological resources in the Gulf and wondered if the gushing well would ever be capped. Millions of gallons and several months later, the ongoing cleanup, injured wildlife care efforts and assessment of the damage wrought took center stage. Historically, scientists and other staff in the US Fish and Wildlife Service's (Service) Environmental Contaminants (EC) Program have taken the lead in contingency planning, spill response, oiled wildlife recovery and care, and natural resource damage assessment for the Service. During the DWH spill, EC staff again took the leading role in these areas, but the magnitude of the event overwhelmed this relatively small program. Staff and managers from many other programs in the Service were engaged to assist in response and recovery activities. Nearly four years later, changing bureau priorities and diminishing Federal budgets have resulted in the Service dismantling the EC Program at headquarters and reducing base budgets for oil-related activities at the regional and field level. While the Service remains committed to addressing the impacts of oil spills, funding constrains have resulted in staff reductions, a loss of expertise, and a more localized effort with respect to spill contingency planning, wildlife recovery and care, and natural resource damage assessment.

SURVIVAL IN MACARONI PENGUINS AND THE RELATIVE IMPORTANCE OF DIFFERENT DRIVERS; INDIVIDUAL TRAITS, PREDATION PRESSURE AND ENVIRONMENTAL VARIABILITY

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Penguins have exhibited dramatic declines in population size, and many studies have linked this to bottom-up processes altering the abundance of prey species. The effects of individual traits have been considered to a lesser extent and top-down regulation through predation has been largely overlooked due to the difficulties in empirically measuring this at sea where it usually occurs. For 9 years (2003-2012), macaroni penguins (*Eudyptes chrysolophus*) were marked with subcutaneous electronic transponder-tags, and re-encountered using an automated gateway system fitted at the entrance to the colony. This system overcomes the long-term effects (including lower survival probabilities) associated with using flipper bands, offering a near complete, continuous detection rate that removes the need for manual observation. We used multi-state mark-recapture modelling to identify the different drivers influencing survival rates and a sensitivity analysis to assess their relative importance across different life stages. Survival rates were low and variable during the fledging year (mean=0.33), increasing to much higher levels from age 1 onwards (mean=0.89). We show that survival of macaroni penguins is driven by a combination of individual quality, top-down predation pressure and bottom-up environmental forces. The relative importance of these covariates was age-specific. Our results suggest that macaroni penguins will most likely be negatively impacted by an increase in the local population size of giant petrels. Furthermore, this population is, at least in the short-term, likely to be positively influenced by local warming.

QUANTIFYING DIET OF LAYSAN AND BLACK-FOOTED ALBATROSSES AND THE EFFECT TO THEIR BODY CONDITION USING STABLE ISOTOPE ANALYSIS

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Both the Laysan albatross (*Phoebastria immutabilis* LAAL) and the black-footed albatross (*P. nigripes* BFAL) are known as scavengers with foraging mainly squids and fish. They prey on different species, according to the stomach content analysis. However, it is hard to detect digestive parts such as muscle or fat from stomach content analysis, and could overestimate non-digestive parts such as bones or squid beaks. In this study, we analyzed carbon and nitrogen stable isotope of tissues in albatrosses and evaluated fat rank by autopsy. We also analyzed stable

isotope ratio of the possible prey species, including floating carcass and fishery discards. Our aim is to examine how the dietary proportion of these preys could relate to fat rank in the albatrosses. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of LAAL was lower than that of BFAL. In the both species there was no sexual difference in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of the small squids, *Oktania anonycha*, and crustacean had lower value compared with other prey species. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of discards seemed to be higher than these of others. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ of squids seemed to be mostly middle of them. Consequently, though isotope ratio differ between two species, both LAAL and BFAL were depended on relatively high in small squids and discards rather than crustacean or small fishes. Estimated dietary proportion of high trophic level fish, which is considered as one of the discards, was related to fat rank of LAAL positively. We discuss how the prey could affect fat rank.

BAHAMIAN SEABIRDS TRANSITION FROM CARIBBEAN TO MID-LATITUDE AND PELAGIC WATERS BETWEEN THE BREEDING AND NONBREEDING SEASONS

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Much of the research that has focused on seabirds in the northwest Atlantic has been conducted in northern latitudes with little effort expended on seabirds that breed in the Caribbean. As part of a growing effort to better understand the ecology and conservation of Caribbean seabirds we have been deploying tracking devices on breeding birds at colonies in The Bahamas, Jamaica, St. Eustatius, Trinidad & Tobago, and Mexico. Here we discuss movement patterns and use of marine habitats by Audubon's Shearwater (*Puffinus lherminieri*) and White-tailed Tropicbird (*Phaethon lepturus*). We attached BAS geolocators to 11 shearwaters and 13 tropicbirds in June 2008 at colonies in The Bahamas. We retrieved 6 devices from shearwaters and 5 from tropicbirds between 2009 and 2013. While breeding birds occurred primarily in north Caribbean waters nonbreeding birds quickly departed colonies for higher latitudes and remained outside of Caribbean waters for 6-8 months. There was a moderate amount of spatial overlap among individuals within species during the nonbreeding season but not between species. Shearwaters tended to winter closer to the North-American shelf while tropicbirds wintered in pelagic waters, in some cases nearing the mid-Atlantic ridge. An assessment of the probability of occurrence within marine ecoregions also confirms that the two proximally breeding species tend to occur in different regions of the northwest Atlantic during much of the nonbreeding period. Conservation

efforts for Caribbean seabirds should recognize that at-sea threats may be far-ranging and varied even for species breeding on nearby islands.

FORAGING HABITS OF GENTOO AND CHINSTRAP PENGUINS REVEALED BY STABLE ISOTOPE ANALYSIS ON KING GEORGE ISLAND, ANTARCTICA

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Determining foraging habits of sympatric seabirds is essential for understanding their ecology, which leads to further management and conservation. The aim of this study was to investigate intra- and inter-specific differences at the trophic level and geographical origin of the diets of two sympatric penguins. We used two stable isotopes, ^{13}C and ^{15}N , in the whole blood of Chinstrap (*Pygoscelis antarctica*) and Gentoo Penguins (*P. papua*) from 13 January to 6 February 2013 on King George Island, Antarctica. As a result, Chinstrap and Gentoo Penguins showed similar trophic level having similar $\delta^{15}\text{N}$ values, but Chinstrap Penguins appeared to forage in more pelagic areas than Gentoo Penguins by having higher $\delta^{13}\text{C}$ values. The males showed a higher trophic level than females for both species, but there was no significant difference in foraging areas between males and females as indicated by $\delta^{13}\text{C}$. According to the isotope comparisons for age, chicks showed lower $\delta^{15}\text{N}$ values than the adults for both species. The finding suggests that adults feed their chicks with prey in the lower trophic level (krills) in comparison to their own diet. Chicks also had lower $\delta^{13}\text{C}$ values suggesting that adults utilize prey from more offshore areas for their chicks. These results suggest the inter- and intra-specific segregation in foraging sites as well as of diet use to minimize possible competition.

ECOSYSTEM SERVICES PROVIDED BY SEABIRDS FOR TERRESTRIAL AGRICULTURE: CORMORANTS FECES CONTRIBUTE FOR RICE CROPS AT PADDY FIELDS NEAR THE COLONY

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Terrestrial ecosystems near seabird colonies can receive a large amount of marine-derived nutrients in the form of the bird feces. Strong effects of the nutrients on plant productivity are well known in forests or coastal grasslands. However, it has rarely been demonstrated the effects of the nutrients on plant productivity in agricultural ecosystems near seabird colonies. We examined those effects on rice plant productivity in paddy fields irrigated by a pond system

located near a colony of the Great Cormorants (*Pharacrocorax carbo*) in Aichi, central Japan. Soils and rice plants in the fields closer to the irrigation pond contained larger amount of cormorant-derived nitrogen (higher $\delta^{15}\text{N}\%$), indicating that those nitrogen could be inputted into the fields via irrigation waters. The amounts of nitrogen provided by the cormorants were estimated over tens of kg in dry weight per year per ha of the paddy field. As the cormorant-derived nitrogen could increase the growth of the rice plants, yields of the rice at the paddy fields enriched only by such nitrogen (without any fertilizers) did not differ from those at the fields enriched by synthetic fertilizers. Our results suggest that seabirds can provide ecosystem services for terrestrial agricultures.

REPRODUCTIVE PERFORMANCE OF THE KITTLITZ'S MURRELET

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The Kittlitz's murrelet (*Brachyramphus brevirostris*) is an unusual seabird endemic to coastal Alaska and Russia and often associated with glacially-affected marine waters during the breeding season. Unlike most seabirds, the Kittlitz's Murrelet does not nest in colonies, but instead nests on the ground in low densities usually in remote, mountainous areas. Consequently, many aspects of its breeding ecology, especially those associated with the pre-breeding period, are unknown. We studied the reproductive performance of the Kittlitz's Murrelet in glaciated Icy Bay in the northern Gulf of Alaska between 2007 and 2012. We radio-marked 191 Kittlitz's and 16 Marbled Murrelets (*B. marmoratus*) and relocated them regularly throughout the breeding season. Across all years, the mean annual proportion of radio-tagged Kittlitz's Murrelets that initiated nesting was 0.20 (SE=0.07) and the probability of success at each nest stage was 0.44 (n=34) for incubation and 0.87 (n=15) for fledging. In comparison, the proportion of nesting Marbled Murrelets was higher (0.81; SE=0.13), as was the probability of incubation (0.69) and fledging success (1.00). We found that breeding decisions of the Kittlitz's Murrelet were associated with sex (males were more likely to breed than females), but not individual body condition, and with increased water stratification during the pre-breeding period, presumably linked to the magnitude and timing of the spring phytoplankton bloom. We conclude that the reproductive performance of the Kittlitz's Murrelet in Icy Bay is poor, especially when compared to the Marbled Murrelet, and that the pre-breeding period when breeding decisions are made is probably the bottleneck.

OCEAN THERMAL STRUCTURE AFFECTS FORAGING BEHAVIOR OF THICK-BILLED MURRES

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The Bering Sea has experienced series of warm and cold regimes leading to abrupt changes in zooplankton and nekton communities. Here we report how variability in the ocean thermal structure affects foraging ecology of thick-billed murres (*Uria lomvia*) breeding on St. George I., southeastern Bering Sea, in 2004, 2006, 2007 and 2013. We used bird-borne dataloggers to measure sea surface temperature, thermocline intensity, temperature at depth > 40 m, foraging trip and flight durations, and diving depth. We also examined inter-annual changes in the diet composition. According to the water temperature at depth, 2004 was the warmest (5.4 ± 0.8 °C) year followed by 2006 (4.5 ± 1.0 °C), 2013 (3.7 ± 0.9 °C), and 2007 was the coldest (2.4 ± 1.2 °C) year. During warm years (2004 and 2006), flight duration was short (1.1-1.3 h) and proportion of squid in the diet was low (10-28%), whereas during cold years (2007 and 2013) flight duration was long (2.0-2.2h) and the proportion of squid was high (38-61%). Birds spent more time foraging in stratified waters in years with intense thermocline (2004, 2007 and 2013) and used both stratified and mixed waters in a year with relatively weak thermocline (2006) with weak thermocline. In all years birds foraged near the thermocline, but in 2007 they also foraged at depth (> 50 m below thermocline). These results suggest that inter-annual variation in ocean thermal structure affected distribution and composition of prey resources, and murres responded by adjusting their foraging range and diving behavior.

SEASONAL AND SPATIAL PATTERNS OF MARINE-BIRD DISTRIBUTIONS IN THE PACIFIC ARCTIC

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Conservation efforts in the Pacific Arctic will require information on species' distributions and the identification of important marine areas. Our goal was to describe broad-scale distributions of marine birds in the eastern Chukchi and western Beaufort seas. Marine bird distributions in the

Arctic are influenced strongly by life-history patterns and the extent of sea-ice coverage. We examined spatial patterns of marine-bird abundance in the summer (15 June–31 August; breeding season, sea-ice retreat) and the fall (September–November; post-breeding and migration, sea-ice minimum). We pooled data from ~50,000 km of at-sea surveys during 2007–2012 to calculate densities (birds/km²) for 10 selected species and 3 foraging guilds in 40-km grid cells. We mapped bird densities and identified cells with significantly higher densities. Analyses were run with and without cells near breeding colonies to minimize “colony effects” on densities. In summer, both divers and surface feeder groups had significantly higher densities at upper Bering Canyon (BC) and between the Bering Strait and southern edge of Hope Basin. Surface feeders also aggregated near the mouth of BC and the continental shelf edge. In fall, high densities of diving birds remained near upper BC and the Bering Strait-Hope Basin edge, whereas surface feeders concentrated in the latter and in the Central Channel between Herald and Hanna shoals. Individual species showed distinct seasonal shifts in distribution. Benthic feeding birds had few hotspots and were close to shore in both seasons. Identifying important marine areas for birds will be complicated by seasonal dynamics and predicted changes in sea-ice coverage.

FIELD METABOLIC RATES OF BLACK-TAILED GULLS INCUBATING TWO AND THREE EGGS

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Factors determining clutch size of birds has been a central issue in ornithology since Lack (1947) hypothesized that parents lay the number of eggs that corresponds to the maximum number of chicks they can rear to independence. It has been demonstrated that a trade-off between reproduction and parental survival plays a significant role in the determination of clutch size. However, physiological mechanism of the trade-off is not unknown yet. In this study, we measured field metabolic rate (FMR) of Black-tailed Gulls (*Larus crassirostris*) incubating two and three eggs, by using doubly labeled water method. We carried out our field study May 2012 and 2013 on Kabushima-Island (40° 32' N, 141° 33' E), Hachinohe city, Japan. Interaction of year and clutch size had a significant effect of FMRs. Foraging conditions in 2012 could be better than 2013 considering from monitoring study of the gulls. Parents incubating 3-egg had smaller FMRs in 2012 than those in 2013 but 2-egg parents did not vary their FMRs between two years. Increments of body mass during the FMR measurements periods were significantly greater for 3-egg parents than those for 2-egg. Three-egg parents would increase their foraging efforts to poor foraging condition but parents for 2-egg did not. Three-egg parents could keep

their body condition at good level in response to foraging conditions but 2-egg parents could not. So, this different response of FMRs for foraging condition could be related to their clutch sizes.

GRADIENTS IN BREEDING BROWN PELICAN FORAGING RADIUS, CHICK CONDITION, AND DIET ACROSS THE NORTHERN GULF OF MEXICO

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Unlike pelagic seabirds whose foraging habitat is generally distant from human development, the Brown Pelican (*Pelecanus occidentalis*) relies on coastal habitats along undeveloped to heavily-developed shorelines. Although pelicans may benefit from supplemental feeding and from prey aggregations around offshore energy installations, they are also vulnerable to contaminants exposure, experience disproportionate oil spill mortality, and represent an important planning and mitigation target. Recent contamination events, notably the 2010 Deep Water Horizon spill, have highlighted the need to understand how pelicans use the marine environment; however, published data on Brown Pelican movement are extremely limited. During summer 2013, we fitted 63 breeding adult Brown Pelicans with solar GPS transmitters at 6 colonies across the northern Gulf of Mexico. We also measured 3-4-week-old chicks at each colony, obtained diet samples from adults and chicks, and conducted behavioral observations to assess short-term capture and tagging effects. Preliminary results indicate that breeding-season foraging radius of adults increased from east (Florida Panhandle) to west (southern Texas), while chick body condition declined along the same gradient. Diet composition also differed between colonies, with spot croaker (*Leiostomus xanthurus*) and pinfish (*Lagodon rhomboides*) predominating in Texas, Gulf menhaden (*Brevoortia patronus*) in Louisiana, and a variety of species in diets from Florida. Tagging did not appear to affect short-term behavior. We plan to further investigate how diet, individual characteristics, environmental factors, and anthropogenic development relate to pelican demography and year-round movement patterns.

COMPARATIVE PERFORMANCE OF CELLULAR AND SATELLITE TRANSMITTERS DEPLOYED ON BROWN PELICANS IN THE GULF OF MEXICO

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Cellular Terminal GPS Transmitters (GSM Transmitters, or CTTs) have recently become available as an alternative to traditional Platform Terminal Transmitters (PTTs), which transmit data through the Argos satellite system. CTT units offer several advantages over PTTs, including reduced data transmission costs, improved data access, and a two-way interface that allows the tag to be reprogrammed after deployment. However, their performance in the field has not yet been tested. During the summer of 2013, we deployed a mixture of CTTs (24) and PTTs (36) on breeding adult Brown Pelicans at 6 colonies across the Northern Gulf of Mexico. Tags were distributed evenly between the Florida Panhandle (2 colonies, NCTT=9, NPTT=11), Terrebonne Bay in Louisiana (2 colonies, NCTT=8, NPTT=12), and the south-central Texas coast (2 colonies, NCTT=7, NPTT=13). To date, we have found a higher absolute failure rate for CTTs than for PTTs, as well as a higher rate of missed data points. While the two-way interface continues to function correctly on many of the CTTs, some tags have not responded to changes in scheduling after deployment. In addition, sections of nearshore waters along the coasts of Louisiana, Florida, and Mexico represent dead zones for CTT transmission, meaning that data obtained from these areas are stored on the transmitters and cannot be downloaded until the tagged bird flies within range of a cellular tower. While many of these issues may be improved by future changes to transmitter hardware and network access, researchers should use caution when deploying CTTs, particularly in marine environments where cellular coverage may be limited.

USING LANDSCAPE MODELS TO PRIORITIZE AREAS FOR NEWELL'S SHEARWATER CONSERVATION

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Threats to the Newell's shearwater (*Puffinus newelli*) including light attraction and fallout, collision with powerlines, predation, and habitat degradation have resulted in a significant decline in the population. We developed a habitat suitability model to identify the location and acreage of suitable habitat for Newell's shearwaters on Kauai, and to identify sites most suitable for management. Our model identified the northwest quadrant of Kauai as the core location where Newell's shearwater can fly to nesting sites without encountering lights. We restricted the area suitable for management to this region, as sites outside would have diminishing returns

because of the increased mortality from light fallout. We developed a PVA, and simulated various management scenarios to identify the probability of persistence of the species under those scenarios.

SO FAR, THANKS FOR ALL THE CARP – CASPIAN TERNS AT MALHEUR NATIONAL WILDLIFE REFUGE, OREGON

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As part of a regional Caspian Tern (*Hydroprogne caspia*) management plan to reduce avian predation on salmonid smolts in the Columbia River estuary, the U.S. Army Corps of Engineers constructed new islands in interior Oregon and north-eastern California that coincided with reductions in Caspian Tern nesting habitat in the Columbia River estuary. In 2012, they built a 1-acre rock-core island in Malheur Lake within Malheur National Wildlife Refuge (NWR) in eastern Oregon. Caspian Terns historically nested at Malheur Lake, but the size and success of the colonies was highly variable due to the dynamic nature of the snowpack-dependent lake system. We used social attraction to draw terns to the new island and monitored colony size, nest success, and diet composition, plus re-sighted banded individuals in 2012 and 2013. Terns were quickly attracted to the site and successfully nested there in both years (232 breeding pairs in 2012 and 530 in 2013). In 2013, however, nest success was limited by cold weather and trampling of nests by American white pelicans (*Pelecanus erythrorhynchos*). The tern diet was composed predominately of native tui chub (*Gila bicolor*) and invasive common carp (*Cyprinus carpio*) during both years of monitoring. Of the carp consumed, most were in the 1+ age class. Band re-sightings suggest a high level of connectivity with Caspian Tern colonies in eastern Washington and the Columbia River estuary. Two years after construction, the island at Malheur NWR shows great potential as Caspian Tern breeding habitat, and should provide that habitat over a much wider range of lake levels than historically has been available in the area.

PELAGIC CORMORANT POPULATION AND REPRODUCTIVE STATUS – THE BEGINNING OF AN ASSESSMENT.

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Pelagic Cormorants (*Phalacrocorax pelagicus*) breed in small and scattered locations along the coast of North America from Alaska to Southern California. A citizen science project has been monitoring selected colonies in Northern California for five years and has documented dramatic annual and spatial variation in breeding success. Some colonies have been occupied every year and others have been occupied sporadically. Estimating the long term population status of this species will require a long effort and a broad geographic scope. In the past year we have expanded the project to include approximately 50 colonies ranging from Central Oregon to Central California. Here we present the results of the past five years and outline the collaboration we hope to develop in the future. The format of the citizen science monitoring that we have been using is potentially a viable way to increase this effort.

COMPARISON OF RAPTOR DIET AT TWO GLACIAL FJORD SYSTEMS: IMPLICATIONS FOR SEABIRDS

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Two main natural predators of seabirds, especially during the breeding season, in the northern Pacific Ocean (Gulf of Alaska) are the Bald Eagle (*Haliaeetus leucocephalus*) and the Peregrine Falcon (*Falco peregrinus*). In Alaska, as elsewhere, populations of both of these apex predators were substantially reduced during the last century due to persecution and effects of environmental contaminants. In recent years, however, populations of both species have recovered fully and, in fact, appear to be occupying previously unused habitats such as those created by receding tidewater glaciers. We studied and compared the diet of Bald Eagles and Peregrine Falcons in two areas of the northern Gulf of Alaska that are at different stages in their glacial history. To describe raptor diet, we identified prey remains at nest sites (578 from Peregrine Falcons; 281 from Bald Eagles). We found that at both sites PEFA feed on more seabirds than Bald Eagle. At Kenai Fjords National park where many large seabird colonies exist, the diet of Peregrine Falcon was diverse and the impact to any single seabird species was minimal. In contrast, at Icy Bay where only a handful of small seabird colonies exist, the diet of Peregrine Falcon consisted primarily of one species, the Kittlitz's Murrelet (*Brachyramphus brevirostris*) as measured by biomass (25%) and frequency (22%), which is also the most

common species in the bay. Thus, increasing Peregrine Falcon populations in this area, or other similar areas, may be having a notable effect on the local population of Kittlitz's Murrelet.

MONITORING AND MANAGEMENT STRATEGIES FOR RESUMING HARVEST OF GULL EGGS IN GLACIER BAY NATIONAL PARK

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Legislation has recently been introduced in U.S. Congress to allow the traditional harvest of glaucous-winged gull (*Larus glaucescens*) eggs by Hoonah Tlingit tribal members in Glacier Bay National Park for the first time in over 50 years. A Legislative Environmental Impact Statement completed in 2010 identifies 15 potential harvest sites and mandates the National Park Service to carry out monitoring of gull colonies to mitigate potential negative resource effects of the harvest. Monitoring results will be applied to an egg harvest plan prepared annually by the park and the Hoonah Indian Association. Gull monitoring efforts initiated in 2012 employed ground and vessel-based census techniques to determine the distribution and abundance of gulls and harvestable nests, and to document other species present that may be impacted by harvest. We found over 1,200 nesting glaucous-winged gulls concentrated at 6 potential harvest locations, ranging from 45 to 180 accessible nests per colony with substantial difference in productivity between years. In 2012, we observed 187 eggs in 672 nests and only one hatched chick. In 2013 we observed 1403 eggs in 664 nests and 437 hatched chicks. Marine mammals (harbor seals, Steller sea lions), protected under the Marine Mammal Protection & Endangered Species Acts, may inhibit harvest at several locations. Park managers, scientists, and anthropologists are beginning to develop a decision-making framework crucial for future harvest plans and have proposed meeting with potential native egg harvesters to update ethnographic information and begin discussing management strategies for future gull egg harvest plans.

USING SEABIRDS AS SENTINELS OF ECOSYSTEM HEALTH OF THE SOUTHERN CALIFORNIA BIGHT: PRELIMINARY RESULTS OF SEABIRDS AND COASTAL ENVIRONMENT CONDITION

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Recent research has demonstrated that seabirds can serve as robust indicators of marine health and can detect changes in ecosystem quality at relevant timescales. Organic contaminants are

found in high quantities in seabirds and their lipid-rich eggs provide a non-invasive sampling tissue. Seabirds also exhibit sub-lethal, physiological effects from contaminant exposure, such as eggshell thinning, reproductive impairments and compromised immune function. For these reasons, seabirds are ideal candidates to act as sentinels of legacy and emerging toxic contaminants in the marine environment and at the land-sea interface. Since 1994, the Southern California Coastal Water Research Project (SCCWRP) has coordinated the S. California Bight monitoring program of sediments, water, fish and invertebrates to improve the efficacy of existing monitoring regimes and large-scale environmental assessments. This effort has never included seabirds. Here we present our preliminary efforts to create a representative regional seabird sampling design. We examine sampling success from four species across 16 different sites throughout the Southern California Bight. We also present preliminary results designed to assess intra-species variability in egg concentrations with differing developmental stages and lipid content. Finally, we present information on results from an intercalibration of nine labs analyzing split samples of contaminants in an egg matrix from a single species. Our data point to the importance of integrating seabird contaminant data within the context of large-scale monitoring programs, and the need for collaborative contaminant monitoring that generates comparable and relevant data among species and sampling locations

WINTERING EIDERS ACQUIRE EXCEPTIONAL SE AND CD BURDENS IN THE BERING SEA: PHYSIOLOGICAL AND OCEANOGRAPHIC FACTORS

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During late winter (March) in the Bering Sea, levels of Se in livers and Cd in kidneys of spectacled eiders (*Somateria fischeri*) were exceptionally high compared to levels in marine ducks elsewhere. Comparison of organ and blood samples during late winter, early spring migration, and breeding suggests that the eiders' high Se and Cd burdens were accumulated at sea, with highest exposure during winter. In the eiders' remote wintering area, their bivalve prey contained comparable Se levels and much higher Cd levels than in industrialized areas. Patterns of chlorophyll a in water and sediments indicated that phytoplankton detritus settling over a large area was advected into a persistent regional eddy, where benthic prey densities were higher than elsewhere and most eider foraging occurred. Se and Cd assimilated or adsorbed to bloom materials apparently also accumulated in the eddy, and were incorporated into the bivalve prey of eiders. Atmospheric deposition of dust-borne trace elements from Asia, which peaks during

the ice-edge phytoplankton bloom from March to May, may augment processes that concentrate Se and Cd in eider prey of the eddy region. Our results suggest that high trace element levels in Spectacled Eiders could result from (1) physiological accumulation and tolerance of exceptionally high trace element burdens when exposure is elevated by high food intake or levels in food, and (2) atmospheric and oceanographic processes which concentrate trace elements in local benthic food webs.

MAPPING PHYSICAL CHARACTERISTICS OF THE COLUMBIA RIVER MOUTH USING DIVING SEABIRDS FITTED WITH ARCHIVAL GPS AND SENSOR TAGS

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We initiated a pilot study in 2013 to investigate the use of diving seabirds as sensor platforms to collect physical oceanographic data at the mouth of the Columbia River (MCR). Seabirds may offer novel sampling opportunities in coastal waters, including sampling in areas difficult to access or under hydrologic conditions where traditional sampling equipment is difficult to safely or successfully operate. GPS-tagged seabirds can be fitted with additional sensor tags, or birds can be fitted with single tags that integrate both GPS functionality and sensor capability, to collect a variety of spatially explicit physical oceanographic data. Bathymetry can be sampled using tags that collect a pressure-based measurement of depth and salinity and temperature patterns can be measured by affixing tags incorporating a conductivity meter and temperature sensor. Cormorants nesting at East Sand Island (river kilometer 8 in the MCR) utilize a large portion of the estuary and near-shore areas surrounding the MCR. During the 2013 breeding season we fitted archival GPS and sensor tags to a small sample of Brandt's Cormorants (*Phalacrocorax penicillatus*; n=5) to test the feasibility of this approach. The preliminary data collected in 2013 demonstrate the potential use of cormorants to measure various physical oceanographic parameters. Cormorants sampled a substantial portion of the MCR, including sites with varying depth, temperature, and salinity. Initial data analysis indicates that maximum dive depths are consistent with sonar-derived bathymetry data, in areas where such data are available. Other analyses are ongoing.

SITTING DUCKS: THE IMPACT OF MOLT TIMING ON THE VULNERABILITY OF SEABIRDS TO A HARMFUL ALGAL BLOOM

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During September to November 2009, over 6,000 scoters, murrees, large grebes, and loons were found beached after a large algal bloom along the Pacific Northwest coast (Northern Washington to Northern Oregon). The senescence of the harmful algal bloom (HAB) of dinoflagellate *Akashiwo sanguinea* together with storm-driven waves broke open cells creating a surfactant that coated the birds' feathers hindering foraging ability and thermoregulation, and ultimately resulting in death. Although seabirds may be able to avoid such harmful conditions, the timing of this event, coinciding with wing molt, may have rendered these species unable to escape. We examined the impact of molt timing on the vulnerability of seabirds to HABs. On northern Washington outer coast beaches in September 2009, 34% of the total beached birds (n=2386 carcasses over 53 surveys) were Surf and White-winged Scoters, and 83% (n=447 carcasses) of these were molting. In contrast, during years 2003-2012 (omitting 2009) on these same beaches, 44 carcasses were found over 652 surveys and 34% (n=15 carcasses) of these were molting. By October 2009 the bloom migrated along the southern Washington coastline, and other species were affected. 50.8% of the total beached birds (n=765 carcasses over 57 surveys) were Common Murrees and 50.6% (n=196 carcasses) of these were molting. Because the molt timing of these species has been consistent across years, resource management should incorporate the implications to seabirds of increasing frequency and earlier phenology of HABs as a result of climate change.

REPRODUCTIVE ECOLOGY AND SUCCESS OF RED-BILLED TROPICBIRDS ON ST. EUSTATIUS

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Few data are available regarding the size, distribution, or breeding success of Red-billed Tropicbirds in the Caribbean. We assessed the breeding ecology and success of Red-billed Tropicbirds *Phaethon aethereus* on St. Eustatius which, along with the nearby island of Saba, supports 33-40% of the global breeding population. Preliminary survey data from Saba suggest that productivity may be near zero and that predation at nest sites is the primary cause of nest loss. We conducted regular nest surveys at five sites on St. Eustatius during the 2013 breeding season. Apparent nest success ranged from 55-100% and apparent fledge success ranged from 63-100% at the five breeding areas on Statia. We used cameras and baited rat traps and documented cats and rats at accessible nests particularly at lower elevation sites nearer to human

habitation. However, substantial nest loss also occurred at more remote sites suggesting either that other factors are affecting nest and fledge success or perhaps that predators typically associated with humans are ranging widely. Additional data on chick growth and adult movement patterns are currently being measured to enhance our understanding of the ecology of Red-billed Tropicbirds at this core breeding island.

EFFECT OF AMBIENT AIR-TEMPERATURE ON FOOD INTAKE OF CAPTIVE SUB-ADULT GREAT CORMORANTS

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Individuals of wild avian species reared in zoos or aquaria may provide unique opportunities for obtaining information for understanding the physiological and ecological traits of those species. Daily food intake and changes in body mass of five, hand-reared sub-adult Great Cormorants (*Phalacrocorax carbo hanedae*) were measured in an outdoor cage at aquaria over 117 days during winter and spring. During the period of the study, the five birds maintained almost constant body masses, despite their daily food intake varying (they were fed ad lib). Daily food intake mass per unit body mass of individuals decreased significantly as the ambient air-temperature increased, but daily body mass increment per unit body mass of individuals did not. These results indicate that the daily energy expenditure of cormorants decreases as ambient air-temperature increases, probably because of the suppression of thermoregulation costs.

SEABIRD CONSERVATION ON O‘AHU OFFSHORE ISLAND WILDLIFE SANCTUARIES

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Various conservation strategies are employed to protect seabirds on the offshore island sanctuaries of O‘ahu. The sanctuaries vary in geology, distance to shore, historical disturbance, species introductions, and public access. All of these factors influence the seabirds nesting on each island as well as the management actions taken to conserve natural resources. Overall program goals are to monitor seabirds, improve seabird habitat by enhancing native plant assemblages, and control predators and invasive species. O‘ahu is the most populous island in Hawai‘i leading to more chance of wildlife interaction with visitors and residents. Human activity is monitored and regulated on popular islands to mitigate wildlife disturbance. A dedicated restoration program and volunteer force is being developed to address management needs. Future directions include developing a stronger monitoring design to demonstrate success of habitat management on seabird populations.

OILED SEABIRD RESCUE AND REHABILITATION: IS IT WORTH IT?

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In the past 50 years, oil spills have repeatedly been observed to be responsible (either directly or indirectly) for the killing of large numbers of seabirds. Invariably, however, each large spill that occurs often generates heated discussions within the scientific community regarding the validity of capturing and providing rehabilitative care to individual oiled animals. During this time period, there have been many improvements and successes in oiled bird care reported from the rehabilitation community, but the practice remains time-consuming, labor-intensive, and costly, and many believe that rescuing and rehabilitating impacted seabirds remains an exercise to appease the demanding public and has little conservation value at the population level. Scientifically valid research studies focused on how well species do in rehabilitation, as well as post-release monitoring studies that can assess the long-term effectiveness of this effort (e.g., post-release survival and successful reproduction) are necessary to appropriately address these questions, yet these publications remain scant and the information scattered. We will present a brief synopsis to set the stage for several of these topics that will be addressed during the special paper session, including benchmarks that can be used for assessing the value of rescue and rehabilitation of seabirds following an oil spill.

OILED WILDLIFE RESPONSE IN NEW ZEALAND: THE C/V RENA INCIDENT

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The grounding of the C/V Rena of the Bay of Plenty in October 2011 is the most significant oil spill incident in New Zealand's history, with the loss of approximately 360 tonnes of heavy fuel oil and an estimated 300-400 containers. An oiled wildlife response capability was mobilized immediately as a fully integrated function of the Incident Control System. Oiled wildlife response strategies included the recovery of live and dead oiled wildlife, and the pre-emptive capture of a threatened species, the New Zealand dotterel (*Charadrius obscurus*).

In total, 420 live oiled birds were admitted for care over a four-month period, with a total of 375 birds released back to the wild (89%). The majority of oiled birds were little blue penguins (*Eudyptula minor*) (n=383), of which 95% were released back to the wild. A total of 60 threatened New Zealand dotterels were pre-emptively captured and housed in captivity for 1 – 3 months, of

which four individuals required washing to remove oil contamination. Fifty-four dotterels were successfully released back to the wild (90%).

Overall, 2083 dead wild animals were collected in the first seven weeks of the response, of which 66% (1379) had some degree of oiling. Of these, 2030 were coastal and marine birds.

Post-release monitoring programmes were set up on release of the little blue penguins and New Zealand dotterels, and monitoring of survival and reproduction will continue over at least two subsequent seasons.

RESEARCH AND CONSERVATION ACTIVITIES ON SEABIRDS DURING 2008-2013 IN SHINAN COUNTY, KOREA

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Shinan County, which consists of a total of 1,004 islands, is located at the south-western end of the Korean Peninsula. Although several breeding sites of seabirds have been known in a few uninhabited islands of Shinan since the early 20th century, little studies and conservation activities in this area have been made. Since 2008, the Korea National Park Service (KNPS) and Shinan County Office started monitoring programs on the breeding seabirds in the county i) to understand the breeding status and the migration ecology, ii) to estimate population changes, iii) to identify potential threats to the local populations and iv) to develop mitigation and conservation measures. Major efforts have been made on two uninhabited islands: Chilbal-do (N 34°47', E 125°47'), and Gugul-do (N 34°04', E 125°07'). Population estimates and monitoring on breeding Swinhoe's Storm Petrels (*Oceanodroma monorhis*), Ancient Murrelets (*Synthliboramphus antiquus*) and Crested Murrelets (*Synthliboramphus wumizusume*) have been conducted, and two tracking studies for Streaked Shearwaters (*Calonectris leucomelas*, 2008-2009) and Crested Murrelets (2013) revealed the first reference information on their migration and habitat use in this area. To promote public awareness and international communication on the conservation of seabirds in the county, the KNPS has co-hosted international symposia since 2007, with Shinan County. In spite of the positive conservation policy of the local government, well-designed and long-term monitoring schemes for securing the sustainable population of the seabirds and their habitats in Shinan County are still required to overcome the lack of information and short conservation history.

IMPACTS OF MAJOR OIL SPILLS IN CALIFORNIA, 1994-2013

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Vulnerability of marine birds to injury from oil spills can be considered a three-stage process, including the likelihood that a bird will: 1) become oiled (driven by abundance, distribution, behavior and environmental conditions), 2) strand onshore alive and be recovered, and 3) be successfully cleaned, rehabilitated, and released. In this study, we examined aspects of the second stage of this process. We reviewed data from 10 major oil spills defined as those affecting >500 birds in California waters since the inception of the Oiled Wildlife Care Network (OWCN) in 1994. The OWCN has worked with California Department of Fish and Wildlife to refine protocols to quantify and reduce impacts to affected wildlife. We quantified the number of taxa affected, ratio of live to dead birds recovered, timing of recoveries, total days of response, and estimated impacts relative to spill volume. For seven spills, we summarized demographic composition of some of the main species affected, Common Murre (*Uria aalge*) and/or *Aechmophorus* grebes. Pelagic species, shorebirds and small-bodied birds may be underrepresented in live strandings compared with dead stranding records. Our results indicate that species vulnerabilities are influenced by the habitat in which the spills occur; spills in the ocean resulted in strandings of fewer species than those in bay/estuary habitats, and resulted in a greater ratio of live to dead birds recovered, potentially indicating greater vulnerability in bay/estuary habitats. We contend that oil spill response and documentation of impacts have improved in California during the last 20 years.

SEABIRD DISTRIBUTIONS AND HYDROGRAPHIC FEATURES IN THE AMCHITKA PASS

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Marine top-predators such as seabirds forage where prey is predictably available under heterogeneous oceanographic conditions at various spatial scales. The Aleutian Passes provide important foraging habitats for breeding seabirds due to strong tidal currents concentrating plankton and thereby creating favorable feeding conditions. We examined how oceanographic features may have enhanced foraging opportunities for seabirds around Amchitka Pass off the central Aleutian Archipelago. Vessel-based surveys were conducted in June 2012 to reveal

seabird distributions across the Amchitka Pass from the North Pacific to the Bering Sea. Prey abundance and currents were measured by acoustic surveys and underway measurements of surface temperature and chlorophyll a were collected with electronic thermosalinograph concurrent with the seabird surveys. Seabird density in the Amchitka Pass was highest (255.6 birds/n.m.) relative to the North Pacific (3.3 birds/n.m.) and Bering Sea (92.8 birds/n.m.). Small alcids such as Crested, Least, and Parakeet Auklet were the dominant species in the Amchitka Pass. Short-tailed shearwaters, on the other hand, were most dominant in the Bering Sea. Chlorophyll a concentrations were highest in the Bering Sea; however, large plankton or small fish abundance, detected via acoustic surveys were highest in the Amchitka Pass. At finer scale, small alcids were significantly concentrated at northern part of the small bank within the Amchitka Pass where upwelling frequently occurs. Local species such as small alcids could potentially detected local oceanographic features such as persistent upwelling relative to the migrant shearwaters from the Southern Hemisphere.

INCLUDING IMPACTS ON SEABIRDS IN A LEGAL CASE AGAINST DISCHARGING FISH OIL AT SEA

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Approximately 200 km off the coast of British Columbia (Canada), a tanker vessel was observed illegally discharging waste crude fish oil by Transport Canada's National Aerial Surveillance Program. In support of the ensuing legal actions pursued by the Canadian Government, the authors were asked to provide expert witness that fish oil was deleterious to seabirds even though it is not considered toxic. It was surprisingly difficult to provide evidence because of a paucity of published information. It is well known that seabirds and other aquatic avifauna are highly sensitive to exposure to petroleum oils, primarily because of the way oil disrupts feathers, resulting in water penetration. We present data from experimental exposure of alcid feathers (collected from Common Murres and Rhinoceros Auklets) to crude fish oil sheens of varying thicknesses. We found measurable changes to feather microstructure and water-oil uptake by feathers with sheen thicknesses as thin as 0.04 μm (barely visible). Wildlife veterinarians and rehabilitary professionals were interviewed to establish linkage between feather-oil interactions and effects on whole birds. All use standardized protocols to minimize exposure to fish oil while being fed in recovery pools. As well, birds were incapable of recovery after exposure to fish oil without some form rehabilitary intervention. The vessel operators in this case were successfully fined, and these results will be used for future cases. These results have also affected policy within Environment Canada and will likely affect other policy that assumes that fish oil is non-toxic and therefore not deleterious to aquatic avifauna.

WHAT DO LITTLE PENGUINS DO ALL DAY? WE TRACKED THEM IN WELLINGTON HARBOUR, NEW ZEALAND TO FIND OUT

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Little Penguins (*Eudyptula minor*) nest along coastlines of southern Australia and both main islands of New Zealand. In an effort to track their daily movement patterns, we attached GPS data-loggers to eight individuals during the chick guard stage of nesting at Matiu/Somes Island in Wellington Harbour, New Zealand. GPS units were set to record positions every minute, providing high-resolution data. After leaving the colony before dawn, individuals rested on the water until commencing rapid directional swimming. Once they had commuted to a foraging site, movement patterns switched to tight turns, dives, and slower speeds. Because signals were lost during diving and swimming speeds have less variation than birds that also fly, analyzing movement data from penguin trips was done with two complementary models: Behavioral Change Point Analysis and K-means Clustering. The total distance traveled averaged 26.6 km in an average monitoring period of 11.7 hours. Parents typically trade duties each night with one parent remaining with the 1-2 chicks during the day while the other parent feeds in the harbour or in Cook Strait.

MIGRATORY PATTERNS OF LAYSAN AND BLACK-FOOTED ALBATROSSES STAYING AT THE WESTERN PACIFIC THROUGH SATELLITE TRACKING SURVEY

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Migratory patterns of Laysan *Phoebastria immutabilis* and black-footed *P. nigripes* albatrosses recently start to being revealed by electronic tracking devices such as PTTs, GPS loggers and GLSs. Previous tracking studies of both albatrosses at their breeding colonies (Hawaiian Islands) and at the Bering Sea showed that the Laysan albatross mainly distributed around the Central Pacific and Bering Sea and that the black-footed albatross mainly distributed around the Central and Eastern Pacific. Although both albatrosses densities were relatively low in the western Pacific, several census studies by research cruises reported that substantial numbers of both albatrosses were found around area off east coast of Honshu and Hokkaido Islands. To understand migratory patterns of both albatrosses in the western Pacific, we conducted a tracking survey for both albatrosses in the western Pacific. 30 Laysan and 18 black-footed albatrosses captured in the western Pacific were tracked by PTT/GPS tags. Daily locations for over 590 days/individual in maximum were fixed by GPS. Many of the Laysan albatrosses spent most of

their time in the area of eastern Honshu while the black-footed albatrosses widely migrated around the North Pacific. Although only two black-footed albatrosses moved to Kure atoll and Sand Island during their breeding season, the others didn't move to their breeding colony. The results suggested that Laysan and black-footed albatrosses staying at the Western Pacific seem to largely include groups at different life-history stages (e.g. non-breeding individuals or juveniles) from the birds mainly distributing around the Hawaiian Islands and Bering Seas.

THE SENSE OF WONDER FOR THE FORAGING HOTSPOTS OF MIGRANT SHEARWATERS IN THE NORTHWESTERN PACIFIC

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The northwestern Pacific has various oceanographic features that support seabird populations throughout the year. The waters off northern Japan have important physical variables such as current fronts, sea ice fronts, and upwelling flow, and this results in some of most highly productive and variable waters in the north Pacific. Shearwater species utilize these waters in different ways so that foraging hotspots vary seasonally and differ among and within species. In this plenary talk, I discuss why the Short-tailed Shearwater (*Puffinus tenuirostris*), a migrant from Tasmania and southeast Australia, died off in different magnitude along the Pacific coast of Japan, just in front of their migratory terminus. What happened in our productive waters? To answer this question, I used several methods: laboratory studies to analyze nutrition, trans-Pacific boat surveys to study shearwater migration routes, field studies at breeding colonies for chick growth, and field and lab experiments for dietary contributions in Tasmania, Australia. These synthetic studies have showed that the mortality of shearwaters was highest during their first migration and was mostly due to energy, that is, the quantity and quality of food provisioned from parents at the nest site before departure to northern hemisphere. In contrast, the Streaked Shearwater (*Calonectris leucomelas*), breeding on Japanese archipelagos and wintering in equatorial waters, utilizes spatial resources differently than Short-tailed Shearwaters in the variable waters off Japan. With the students like ninjas, we have documented the exquisite strategies that shearwaters use to raise their chick and their foraging behavior in the variable environments of the northwestern Pacific. I will conclude my talk by discussing the ongoing issue of population restoration at key colonies for the shearwaters.

HISTORICAL HUNTING, HARVESTING, AND LOCAL FISHING BYCATCH OF THE JAPANESE MURRELET AT BIROJIMA, MIYAZAKI-KEN, JAPAN

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Information on hunting, harvesting, and local fishing bycatch of Japanese Murrelets (*Synthliboramphus wumizusume*) in the Birojima area, Miyazaki-ken, Japan, was obtained through interviews with local residents. Egg harvesting occurred between about 1912 (or possibly earlier) and 1992, but was heaviest in the 1940s to 1975 during and after World War II at roughly 1,800 eggs per year. Lower levels of egg harvesting likely occurred between 1912 and 1940 (about 900-1,200 eggs per year) and between 1976 and 1992 (about 0-200 eggs per year). Hunting of small numbers (<5 per year) is known between 1951 and 1983, and likely occurred before 1951. Heavy bird harvesting (120-225 adults per year) occurred during egg harvesting in 1971-1973 but likely did not occur to a great extent prior to 1966 or after 1975. Harvesting and hunting of Japanese Murrelets became illegal in 1918 but for many reasons people did not follow these regulations until seabird biologists occupied the island in 1993-1994, and the Kadogawa government has been educating fishermen and the public since 1992. Local fishing bycatch of small numbers was reported in 2012-2013 and is assumed to have occurred at least since the 1940s. A rough estimate of hunting and local bycatch mortality in the 1940s to 1970s is 10-30 murrelets per year. The population size of murrelets at Birojima likely was reduced in the 1940s to 1980s but likely recovered to a great extent by 1993-1994 when this colony of the Japanese Murrelet was found to be the largest in the world.

PARTITIONING OF PELAGIC RESOURCES REVEALED BY GPS TRACKING OF BREEDING RED-LEGGED AND BLACK-LEGGED KITTIWAKES

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We investigated the spatial foraging distribution, diet, and fledging success of two closely-related and sympatric seabird species, the Red-legged Kittiwake (*Rissa brevirostris*) and Black-legged Kittiwake (*Rissa tridactyla*) nesting on St. George Island, in the southeastern Bering Sea during 2010. We deployed GPS data loggers on chick-rearing adults of both species

simultaneously and collected regurgitations during captures. The Alaska Maritime National Wildlife Refuge long-term monitoring program measured fledging success concurrently. We found differences between species in foraging habitat, occurrence of prey species and fledging success. Black-legged Kittiwakes made more foraging trips over the continental shelf than Red-legged Kittiwakes, which mostly foraged over the basin beyond the shelf break. Black-legged Kittiwakes fed on euphausiids and three species of myctophids (*Stenobrachius leucopsarus*, *S. nannochir*, and *Nannobrachium regale*). In contrast, Red-legged Kittiwakes primarily fed on one species of myctophid (94%, *S. leucopsarus*) and tended to forage further south when over the basin. Previous studies have found that both kittiwake species fed primarily on *S. leucopsarus*. Fledging success of Black-legged Kittiwakes (0.36 fledglings/nest) was lower than Red-legged Kittiwakes (0.65 fledglings/nest), possibly due to reduced availability of key forage fishes over the continental shelf in 2010. In summary, our results demonstrate resource partitioning by closely related kittiwake species in the southeastern Bering Sea.

COMPARISON OF THE BREEDING PHENOLOGY AND NEST SITE CHARACTERISTICS IN THE TWO SYMPATRIC MURRELET SPECIES ON GUGUL-DO ISLAND

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Two species of *Synthliboramphus* in the Family Alcidae, the Ancient Murrelet (*S. antiquus*) and the Crested Murrelet (*S. wumizusume*), breed on uninhabited islands in Korea. Gugul-do (Island), which is located in the western-southernmost part of Korea, is the only area known so far that the two murrelet species consist a mixed breeding population. We monitored breeding ecology of the two murrelets species since 2012. Among the 155 nests (2012) and 89 nests (2013) we found, 21 and 17 nests those were regularly accessible and species was confirmed with presence of the parent in the nests were used in the analysis. Breeding timing of the two species differed significantly: the Ancient Murrelets started incubation earlier and their chicks hatched also earlier than the Crested Murrelets in both years. Hatching success and fledging success of the Ancient Murrelets was 56% and 100% in 2012, 79% and 100% in 2013, those of the Crested Murrelets was 69% and 83% in 2012, 53% and 100% in 2013. Comparison of the nest site characteristics was conducted in 2013. The mean nest altitude and slope were significantly lower in the Ancient Murrelets than in the Crested Murrelets. Differences in breeding phenology and nest sites may indicate that Ancient Murrelets, which are bigger and arrive earlier, take dominant position in the competition for nest site against Crested Murrelets. To our knowledge, there has been no study on the interspecific competition for breeding between the two murrelet species.

FEMALES FORAGE FARTHER: BI-MODAL FORAGING DISTRIBUTION OF CASPIAN TERNS BREEDING AT A COLONY IN INTERIOR WASHINGTON

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Breeding seabirds are constrained by the location of their nest site relative to potential foraging areas. For piscivorous birds breeding at inland sites, nest location can be especially restrictive because of limited proximity to aquatic habitats. Potholes Reservoir, in central Washington, supports a moderate-sized Caspian Tern (*Hydroprogne caspia*) colony (340 breeding pairs in 2013). The reservoir has an area of 63 km² and is surrounded by a matrix of smaller lakes and wetlands; however, diet studies indicate some terns from this colony forage on juvenile salmonids in the Columbia River, which is a minimum of 32 km away. We used remotely downloadable GPS tags to track 22 breeding Caspian terns during 97 foraging trips (10 females and 13 males). Females with eggs were more likely (0.96 probability) to make long trips, >30 km from colony, than males with eggs (0.25 probability). Only three terns were tracked while attending chicks, 1 female and 2 males; all of these 9 trips occurred within 19 km of the colony. Multiple foraging trips were recorded for 19 terns, only seven of which employed both long and short trips. Two terns made extremely long trips to the Snake River, between 87 and 93 km from the colony, which lasted over 9 hrs each. These are the longest distance foraging trips ever documented for breeding Caspian terns. Greater reliance on foraging in distant large river habitats indicates that incubating females from this colony may have different energetic needs than males and benefit from abundant, high-quality prey available in the Columbia and Snake rivers.

SEABIRD RESEARCH & MANAGEMENT ON THE ISLANDS OF MAUI NUI

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Seabird populations on the eight southernmost Hawaiian Islands have decreased dramatically since human arrival on the archipelago. A host of anthropogenic factors, including habitat alteration, the introduction of non-native species, and development, have contributed to this decline. Several groups on the islands of Maui Nui: Maui, Moloka'i, Lāna'i and Kaho'olawe, are engaged in research and management that strive to locate, protect, and enhance local seabird populations. We synthesized efforts accomplished between January-December 2013 for nine of these entities. Groups polled for this summary are federal, state and private organizations. In

addition to groups with staff on the ground, we have included those with planning and funding responsibilities. Work accomplished within this time frame included predator control, habitat management, surveys, fencing, burrow delineation & monitoring, and other population enhancement actions. These data are used to describe the status of management and research on Maui Nui and provide a basis from which to predict the direction work with seabirds on Maui Nui is headed or could be heading. We present this summation to bring awareness of the work to a larger audience, to share perspectives among seabird researchers and managers in Hawaii, and to solicit input from others about their priorities.

HABITAT AFFINITIES AND AT-SEA RANGING BEHAVIORS AMONG MAIN HAWAIIAN ISLAND SEABIRDS

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The Main Hawai'ian Islands (MHI) and associated offshore islets (i.e, Mokumanu, Lehua, and Molokini) provide substantial breeding habitat for more than 19 seabird species. The Bureau of Ocean Energy Management (BOEM) and the State of Hawai'i have received proposals to develop offshore renewable energy related projects within waters surrounding the MHI that have the potential to negatively impact seabirds which have been documented to interact with wind-turbine structures, lighted facilities, and elevated power lines on land and lighted ships in the area. In 2013, USGS-Western Ecological Research Center initiated collaborative at-sea tracking studies of MHI seabirds to provide information needed by BOEM to assess the level of risk that proposed offshore energy developments have to MHI seabirds. Risk depends on seabird behavior at sea (e.g., time per area, soaring flight behavior associated with wind speed/direction and wave height/direction). Studies in 2013 focused on intra-seasonal and inter-colony differences in the foraging behaviors among Wedge-tailed Shearwaters (*Puffinus pacificus*) and Hawai'ian Petrel (*Pterodroma sandwichensis*) whereas the petrels displayed extreme, long distance foraging loops, shearwaters spend considerable time foraging within Hawai'ian territorial waters and beyond. Among multiple MHI colonies examined we discovered important areas at sea were shared by individual shearwaters foraging from discrete colonies. Such patterns in foraging extent will be important for understanding resource partitioning and the potential roll of interference competition among colonial seabirds in sub-tropical ecosystems.

DIETARY OVERLAP AND COEXISTENCE OF TWO SYMPATRIC PISCIVOROUS SEABIRDS: COMPETITION OR SUPERABUNDANT PREY?

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Ecologically similar predators are expected to partition resources to avoid a high degree of niche overlap and competition. The degree of overlap may reflect resource availability, however, which can be dynamic through time. Periods of greater resource availability may allow greater niche overlap without the negative consequences of competition and conversely, periods of limited resource availability may induce greater niche partitioning or greater competition. This study investigated diet diversity, composition, and overlap of two sympatric piscivorous seabirds, Caspian Terns (*Hydroprogne caspia*) and Double-crested Cormorants (*Phalacrocorax auritus*), during 2005-2012. Diet samples were collected from major nesting colonies of each species (> 5,000 breeding pairs per colony) in the Columbia River estuary of the western USA. Significant interspecific differences in diet composition were seen in all years, although most prey types were utilized by both predators. Differences in diet likely resulted from behavioral and anatomical differences between predators. Dietary overlap, as measured by Pianka's overlap index and Multi-Response Permutation Procedures (MRPP), was relatively high across all years, although inter-annual differences were seen. Annual productivity was variable across the study period for both predators as well; however, there was no relationship between the degree of dietary overlap and annual productivity of either species. We conclude that during the 8-year study period, potential negative effects of interspecific competition for food were absent, presumably due to superabundant prey. Top-down effects or prey quality (mass) were likely more important factors regulating populations of each species.

FORAGING ECOLOGY OF MASKED BOOBIES (*SULA DACTYLATRA*) BREEDING IN THE GULF OF MEXICO

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A major research challenge is to determine the environmental, social, or instinctual cues that individuals use to distinguish suitable habitat. However, in marine environments, where prey

appear to be patchily distributed within a heterogeneous matrix, the interactions that influence such habitat selection may be complex and therefore difficult to identify. We sought to determine habitat selection and foraging behavior of Masked Boobies breeding at a large colony within the boundaries of Arrecife Alacranes National Park, Mexico. We deployed GPS tracking devices on chick-rearing birds during both the spring and autumn breeding seasons of 2013. Deployments lasted 2.5 days on average. Foraging trips occurred primarily during daylight and lasted 8.2 ± 5.6 hours with an average maximum distance from the colony of 145.7 ± 113.2 km. Total distance traveled on foraging trips was 334.1 ± 138.2 km, with no significant difference between sexes. Birds foraged primarily south of the colony over shelf waters. No birds were observed foraging over pelagic Gulf waters. Given the lack of information about habitat use of seabirds throughout the Gulf of Mexico, our data, when combined with other tracking efforts in the northern Gulf and Caribbean, will aid in the identification of at-sea locations of high foraging activity as an indicator of fish activity, a predictor of bird exposure to pollutants in the marine environment, and a scientific basis for decisions regarding reserve structure.

SPATIOTEMPORAL PATTERNS AND ENVIRONMENTAL CORRELATES OF LONG-TERM CHANGES IN ALEUTIAN TERN POPULATIONS OF ALASKA

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We are investigating patterns and potential causality of long term changes in breeding colonies of Aleutian Terns, the status of which has recently been questioned due to anecdotal reports of declines and local extinctions. To evaluate the significance of these changes, we are using a statewide database (n=121 colonies total) to estimate the variance associated with longer term changes (> 1 decade; n=56) relevant to typical interannual variance at individual colonies (n=35). We are also investigating potential correlates of population anomalies by evaluating the relevance of colony size and location, geographical trends and scale of spatial autocorrelation/clustering, and potential external stressors like proximity to anthropogenic disturbance and regional changes in marine productivity and temperature anomalies in the Gulf of Alaska, Bering, and Chukchi Seas. We will also discuss potential stressors outside of the breeding season in light of recent data we have collected on over-wintering locations in the Javan and Bismarck Seas of the Western Pacific.

WHEN A SEABIRD CALLS IN THE FOREST AND NO ORNITHOLOGIST IS AROUND TO HEAR IT - DOES A SONG METER RECORD ITS SOUND?

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Rare nocturnal seabirds nesting in remote upper montane forests are notoriously difficult to study. Furthermore, intensive monitoring of active burrows can lead to unintentional conservation impacts such as the destruction of nesting vegetation. The Kaua'i Endangered Seabird Recovery Project has been working extensively with song meters (acoustic recording devices) to assess how this technology can be most effectively used to overcome these challenges in monitoring efforts for the Newell's Shearwater *Puffinus newelli* and Hawaiian Petrel *Pterodroma sandwichensis*. Units have been deployed at fixed locations within colonies throughout the breeding season to monitor seasonal patterns of colony attendance, providing information on first arrival dates at colonies and peak activity periods. Initial results suggest that average call rates are related to the density of breeding burrows around acoustic survey sites. This relationship may allow us to use acoustic metrics to (i) estimate relative abundance at breeding colonies and (ii) create an index for monitoring population trends over time. However, understanding the differences between aerial calling birds in transit and birds ground-calling at breeding sites needs further study. A second use of song meters is to find unknown breeding sites in inaccessible locations. Roving units were deployed on an exploratory basis by helicopter into previously un-surveyed areas and subsequently identified new activity hotspots of both species. The use of song meters to monitor and locate endangered seabirds in remote montane areas promises to be an effective tool that has broad applications both on Kaua'i and other areas with similar species, habitats and challenges.

WHY TIMING IS EVERYTHING: CONSEQUENCES OF RESOURCE MISMATCH FOR A CHICK-REARING SEABIRD AT AN ENERGY CEILING

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Timing reproduction to overlap with peak prey availability is vital to success for many species. This may be especially true for species operating at an energetic ceiling as they risk energy deficits if they attempt to compensate for limited access to prey. Any mismatch must be mediated by parents through flexible changes to activity that keep them below their energetic limits. In Newfoundland, common murre (*Uria aalge*) time breeding to coincide with the inshore movements of capelin (*Mallotus villosus*) – their primary prey – such that peak prey availability overlaps with chick-rearing, the murre's most energetically demanding phase of

breeding. We use colony-based observations and temperature-depth recorders to track the behavioural responses of murrelets to temporal match and mismatch with capelin. Activity budgets, daily energy expenditure (DEE) and chick-provisioning rates were constant across years when chick and capelin timing matched. When capelin were late however, despite increasing diving effort and DEE, parents delivered fewer fish to chicks per day. While parents presumably buffered the effects of variable capelin abundance by reducing co-attendance time (time spent at the colony with mates) by more than 3 h per day, the extra foraging time was not sufficient to maintain chick-provisioning rates in a mismatch year. Short-term reliance on energy reserves likely helped murrelets overcome an energy ceiling and limit breeding failure. Such responses could have demographic consequences if ocean climate changes decouple the timing of chick-rearing and capelin availability.

OVERLAPPING SHIPPING TRAFFIC AND SEABIRDS IN THE ALEUTIAN ARCHIPELAGO: A SEASONAL RISK ANALYSIS

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Some of the largest seabird concentrations in the northern hemisphere are intersected by a major shipping route through the Aleutian Archipelago (AI) of Alaska. Using data from the North Pacific Pelagic Seabird Database and bathymetry and oceanography, we build a seasonally predictive model of seabird distribution, using random forests. We fit one model for each of ninety species. Colony-effect, sea-surface-temperature, and month are the most important variables to predict distributions. Combined abundance peaks in August, with major concentrations around Unimak Pass in the eastern AI, and along the continental-shelf edges. During summer, the avian community is dominated by short-tailed shearwater (*Puffinus tenuirostris*). Their abundance drives the seasonal patterns of seabird densities. We multiply seabird densities with an oil-spill vulnerability index for each species, thus obtaining seasonal maps of oil vulnerability. To assess risk, we combine this index with an index of shipping vessel density. Shipping density is our proxy for the probability of an accident at a particular location and time. The risk is greatest where a high likelihood of an incident coincides with high vulnerability. We identify high-risk areas around Unimak Pass, on the south-side of the Alaska Peninsula, and through two passes in the western AI. The risk is highest in Unimak Pass and south of the Alaska Peninsula. Our results can be used for defining marine protected areas, proactive planning of shipping routes and staging of response resources, and as a management tool in the event of a shipping accident.

ALEUTIAN TERN UPDATE: IT'S TIME TO BE CONCERNED ABOUT *O. ALEUTICUS*

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Following indications of local declines or disappearance of Aleutian tern (*Onychoprion aleuticus*) colonies, we assessed trends in the breeding-colony distribution and population status of the species throughout Alaska. We compiled recent survey data and, along with multiple partners, conducted targeted colony counts, to generate an up-to-date population estimate and to evaluate population change in recent decades. Monitoring the size of Aleutian tern colonies is challenging given variable survey methodology over the years, annual variation in attendance, common breeding failure, and occasional colony movement. Nonetheless, we judge there is sufficient evidence that the species has declined dramatically. We also compiled information on potential threats to the species, and while no single population-level stressor seems obviously to blame for the decline in Aleutian tern numbers, several factors play a substantial role in population change at local scales and their cumulative impact may be implicated at the population level.

PATTERNS OF ANTHROPOGENIC THREATS TO SEABIRDS IN THE NORTH PACIFIC

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Given that many species of seabird spend a majority of their time at-sea, the threats they encounter there are likely to have significant importance for survival, health and breeding success. At the same time, at-sea anthropogenic threats are not well-known. When they are studied, these threats are often considered in isolation, though additive or synergistic effects are undoubtedly important. To assess the distribution and patterns of at-sea anthropogenic threats specific to seabirds, we created a spatially explicit map for the North Pacific. The map includes relative levels for 10 threat categories, with data spanning the Pacific from the equator to 66°N latitude. These threats include three categories related to fisheries: bycatch, trophic disturbance through biomass removal, and direct competition; five categories of pollution: organic chemicals, inorganic chemicals, large oil spills, maritime transport pollution, and marine debris; and two climate change categories: sea surface temperature anomaly, and wind pattern change. We analyze the map to reveal the areas of highest and lowest threat, as well as regions of highest and lowest number of threats. In addition, we assess threat by Exclusive Economic Zones (EEZs) of nations and compare these across nations and discuss these in relation to the rankings

of ‘priority countries for seabirds’ as reported by Croxall et al. (2012). Threats in the North Pacific appear to place some ecosystems of vital importance to seabirds at especially high risk.

POPULATION UP, PRODUCTIVITY DOWN: FOUR DECADES OF CHANGE IN BLACK-LEGGED KITTIWAKE DEMOGRAPHICS AT CAPE LISBURNE, ALASKA

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The high rocky sea cliffs of the Lisburne Peninsula host the largest populations of nesting seabirds in the eastern Chukchi Sea. Cape Lisburne, one of Alaska Maritime National Wildlife Refuge’s long-term annual seabird monitoring sites, supports an estimated 20,000-30,000 black-legged kittiwakes (*Rissa tridactyla*). Black-legged kittiwake reproductive success has been monitored since 1976, and population counts have been conducted since 1977. In this time period, we have observed contrasting significant linear trends in reproductive success (decreasing) and population (increasing). Reproductive success at Cape Lisburne is nearly twice as high both in terms of long-term (average 59%) and maximum individual yearly mean compared to other monitoring sites in Alaska. However, it has decreased consistently throughout the study period, with low to complete failure becoming more frequent and a reduction in high values. Paradoxically, land-based counts have shown a 3.4% annual increase and boat-based counts on a broader area show a similar trend. The Arctic system is heavily influenced by sea ice which is known to be undergoing a period of rapid change, presumably affecting prey distribution. We will explore relationships in demographic parameters of black-legged kittiwakes at Cape Lisburne with climate and other environmental variables and compare these to other colonies in different Alaskan marine systems.

SEABIRDS AND OFFSHORE OIL AND GAS PLATFORMS: TRACKING THE FREQUENCY, TIMING AND DURATION OF INTERACTION EVENTS

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Difficulties associated with direct observations from offshore platforms and the episodic nature of bird-platform interactions mean that there is poor documentation of bird activities at offshore oil and gas installations. Assessment of bird-platform interactions could be improved by incorporating instrument-based approaches with traditional environmental monitoring. Using a range of marking, telemetry and bio-logging technology, we studied five seabird species to quantify the frequency, timing, and duration of bird-platform interactions in Atlantic Canadian

waters. Geolocation sensing tags quantified foraging ranges of Leach's Storm-petrels (*Oceanodroma leucorhoa*) from two mainland colonies and identified very little spatial overlap with offshore platforms. We developed open-source automated VHF receivers (sensorgnome.org) which were deployed in a network array on vessels, seabird colonies, and coastal sites to quantify colony attendance and track the movements of VHF tagged gulls (*Larus* spp.) and terns (*Sterna* spp.). Terns foraged >20 km from colonies but were not detected near offshore platforms. Gulls showed frequent associations with platform supply vessels, typically at night, and the frequency of interactions peaked in July and August post breeding. GPS-satellite telemetry tracked gull foraging trips ranging from 5 to 275 km from the colony and apparent "specialization" by a few individuals attending platforms regularly. We demonstrate the versatility of telemetry devices to quantify landscape-scale movement patterns and seabird interactions with offshore industrial installations. We discuss the potential integration of these technologies with other sensors such as radar, acoustic, and thermal imaging.

PENGUINS CLEARLY BENEFIT FROM REHABILITATION FOLLOWING EXPOSURE TO OIL

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Globally, penguins are amongst the seabirds most frequently exposed to oil in the marine and coastal environments, due to their marine foraging and terrestrial nesting. Penguins are robust and resilient species compared to most seabirds, and widespread throughout the Southern Hemisphere. Current rehabilitation protocols and release criteria have been developed, evolved and matured in the past two or three decades from treating tens of thousands of oiled penguins. These protocols and strict release criteria ensure high levels of successful reintegration into the wild, as demonstrated by satellite tracking studies and post-release analyses of banding data. These studies show survival in the wild over several years and rehabilitated birds travelling hundreds to thousands of kilometres from their release points. High release and low mortality rates characterize contemporary treatments for oiled penguins. The protocols and release criteria have been successfully modified between species of penguins and for other seabird species,

many of which have an elevated IUCN conservation status. In the absence of proper treatment protocols, a single oil spill event has the potential for catastrophic impacts on single-island or relict-population species such as Galapagos penguins (*Spheniscus mendiculus*) or Fiordland penguins (*Eudyptes pachyrhynchus*), respectively. The available data clearly demonstrate that penguins benefit from rehabilitation following exposure to oil, and for these species rehabilitation is considered a useful conservation tool.

MONITORING BLACK-CAPPED PETRELS (*PTERODROMA HASITATA*) NESTING AT MORNE VINCENT, HAITI AND LOMA DEL TORO, DOMINICAN REPUBLIC

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The Black-capped Petrel (*Pterodroma hasitata*) is an endangered seabird thought to nest only on the island of Hispaniola. Despite great conservation concern, until recently little has been known about location of breeding sites, reproductive success, or predators. Since 2011 we have been monitoring nests at Morne Vincent, Haiti and Loma del Toro, Dominican Republic. We used endoscopes and direct observation to document nesting activity in burrows, and camera traps to document activity of petrels and predators at nest sites. In 2011, of three active nests found, only one fledged. In 2012, of 29 nests found, 23 (79%) fledged. In 2013, of 38 active nests found, 30 (79%) fledged. Camera trap data show rats are common at all sites, however we did not document any predatory behavior. Predation by cats or mongoose has not been directly documented, and its importance remains unclear. Humans appear to prey on petrels opportunistically at Morne Vincent. Forest fires may have been a major cause of nest-site destruction at Loma del Toro in the past. At Morne Vincent, land-clearing for agriculture threatens the nesting area. We are beginning to integrate the nearby community of Boukan Chat into conservation activities aimed at alternative land use and reforestation to avoid further encroachment on nesting area. Radar surveys in 2013 documented important petrel flight paths elsewhere on the island. During intensive search in the Cordillera Central of the Dominican Republic, a petrel tibiotarsus was found; search for nest sites in new areas will continue in 2014.

FINE-SCALE DIVING STRATEGIES OF RHINOCEROS AUKLETS FEEDING ON JAPANESE ANCHOVY

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Diving seabirds are expected to adjust their underwater behavior to feed on their mobile prey fish efficiently. However, few studies examined how diving seabirds adjust their diving behavior to feeding conditions because it is difficult to monitor bird behavior and prey capture events simultaneously. Here, we studied the fine-scale diving behavior of breeding Rhinoceros auklets with time-depth-accelerometers logger at Teuri Island, Japan, in 2012 and 2013. From acceleration data, we computed wing-beat frequency and pitch angle for each second. We observed a short period of high wing-beat frequency (4-6 Hz) during the bottom and ascent phase in 23.7 % of all dives (n =1951, from 16 birds), which were presumably related to chasing and capturing attempts of prey. Therefore, we defined the dives with the short period of high wing-beat frequency as ‘foraging dives’, and the rest as ‘cruising dives’. ‘Foraging dives’ were most frequently observed in the evening (16:00 - 20:00), before returning flights to the colony. The pitch angle of ‘foraging dives’ was steeper than ‘cruise dives’ during both descent and ascent phases. The auklets can reach target depth sooner with steeper pitch angle during descent phase of ‘foraging dives’, and can search over larger horizontal distance with shallower pitch angle during both descent and ascent phase of ‘cruising dives’. We suggest that Rhinoceros auklets adjust their diving pitch angles to the foraging context of searching or feeding, to feed efficiently on their mobile and ephemeral prey, the Japanese anchovy.

EGG VOLUME OF THE BLACK GUILLEMOT (*CEPPHUS GRILLE MANDTI*) IN ARCTIC ALASKA IS CORRELATED WITH THE PACIFIC DECADAL OSCILLATION (1978-2012)

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Major changes have occurred in the Arctic in recent decades associated with well documented reductions in summer sea ice and increases in sea surface temperature. Knowledge of the associated effects on arctic marine ecosystem is limited, however. Seabird breeding colonies offer a unique and inexpensive opportunity to measure those effects. Cooper Island, Alaska hosts a colony of Black Guillemots (*Cephus grylle mandti*) monitored since 1975. The colony experienced rapid growth from 18 to 200 pairs (1975-1989), as nesting cavities were created, and then a decline to <150 pairs in the mid-1990s.

Our initial examination of annual variation in egg volume (from 1978-2012), found an increase in egg volume during the 1980s and early 1990s, with a decline during the first decade of the 21st Century. Preliminary analysis yielded models showing significant correlations between egg volume and lay date, body mass and breeding experience of the female, and the Pacific Decadal Oscillation (PDO) with a one-year lag. Annual variation in seabird egg size can reflect both female condition and pre-laying prey availability. The observed long-term trajectory in guillemot egg size could reflect changes in the population's age-structure, with egg size increasing in a maturing population and decreasing in an aging one, or changes in the availability of prey in the pre-breeding period. Increases in the PDO reflect increasing sea surface temperature in the North Pacific and the positive correlation with egg size could indicate increased availability of prey in warmer years.

TUFTED PUFFINS AS FORAGE FISH SAMPLERS ACROSS THE ALEUTIAN CHAIN

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Forage fish, including small-schooling fish and moderately large invertebrates, are central to predator-prey relationships and seabird population dynamics. Despite their ecological significance in the food web and as juvenile cohorts of commercially important species, forage fish are understudied and are rarely monitored due to a variety of factors making their research challenging. Conveniently, Tufted Puffins (*Fratercula cirrhata*) are efficient predators of forage fish, and deliver a variety of prey species to their burrows during the chick rearing season. The diet of Tufted Puffin chicks, therefore, can provide an index of prey availability and fish community structure near puffin colonies. We sampled the diets of Tufted Puffin from 16 colonies across the Aleutian Archipelago from Attu to Unimak islands, August 13-22, 2012 and 2013. We screened >3300 puffin burrows, waited for adults to provision chicks, then collected and identified prey. We collected 486 chick meals of over 4,000 individuals and 35 forage fish species. Walleye pollock (*Theragra chalcogramma*) dominated chick diets in the eastern colonies, representing 67% of total biomass, whereas Atka mackerel (*Pleurogrammus monopterygius*) were the primary prey in the western colonies (60% of total biomass). To investigate relationships between chick condition and prey we assessed the body condition of 266 puffin chicks. Additionally, we conducted at-sea seabird surveys around and between colonies to explore spatial relationships between these predators and their prey. Using seabirds as indicators of forage fish allows insight into both elusive forage fish communities and the correlation between the condition of seabird chicks and their prey.

POLLUTION CANARY - ALBATROSS AS SENTINELS OF MARINE POLLUTION

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Mercury and plastic pollution levels in the Pacific Ocean are considered to be increasing with high levels of mercury, lead, and plastic documented in North Pacific albatross species. Our group has shown that changes in methylmercury levels, in Black-Footed Albatross (*Phoebastria nigripes*) (BFAL) have increased as predicted from anthropogenic mercury emissions using museum specimens spanning the past 130 years. At the local scale, lead paint exposure from buildings on their breeding ground affected the population viability of Laysan albatross (*Phoebastria immutabilis*) (LAAL), suggesting albatross are threatened by heavy metal exposure at both local (lead) and global scales (mercury). Plastic pollution in the oceans accumulates in zones of high density or “gyres”. Our pilot study indicates that plastic can leach potentially toxic concentrations of metals (e.g., lead, zinc). Since the BFAL and LAAL feed at the top of the marine food chain, range across the Pacific, and feed along the gyres of plastic pollution, they are ideal sentinel species for marine pollution. Further, our group used an age specific population model for Laysan Albatross to demonstrate that field observed mortality in chicks, related to plastic ingestion, could be linked to long-term population impact. Therefore, we propose that North Pacific albatross are an effective marine flagship species and understanding their exposure risks will support broader biodiversity conservation across the North Pacific.

HEAVY METAL CONCENTRATION IN THE EGG SHELLS OF CRESTED MURRELETS ON GUGUL-DO (ISLAND), KOREA

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The biggest breeding site of the Crested Murrelet (*Syntliboramphus wumizusume*) of Korea is located in the Yellow Sea, which suffers from pollutants such as industrial waste waters and microdusts. Therefore, the murrelet breeding site, Gugul-do (Island), has a possibility of being exposed by the pollutants, especially heavy metals such as cadmium (Cd), lead (Pb), and mercury (Hg). These heavy metals are accumulated along the trophic levels, thus severely affect to seabirds, the top predators of the marine food web. This study was conducted to monitor heavy metal concentration in the Crested Murrelets on Gugul-do using non-invasive monitoring

method. We collected eggshells after hatching and eggs those failed to hatch at the end of the breeding season in 2012-2013. There was no variation of heavy metal concentration in the eggshells: $0.015 \mu\text{g/g} \pm 0.016$ (2012) and $0.010 \mu\text{g/g} \pm 0.007$ (2013) in Cd, $0.213 \mu\text{g/g} \pm 0.073$ (2012) and $0.242 \mu\text{g/g} \pm 0.071$ (2013) in Pb, $0.018 \mu\text{g/g} \pm 0.036$ (2012) and $0.024 \mu\text{g/g} \pm 0.030$ (2013) in Hg. We found no differences in heavy metal concentration by hatching success and no relationships between heavy metal concentration and egg size. However, cadmium concentration was negatively correlated to eggshell thickness, although there was no relationship between eggshell thickness and hatching success. To sum up the results, current heavy metal concentration does not seem to affect annual breeding success of Crested Murrelets on Gugul-do, however, cadmium concentration may have minor effect on fledging success, chick growth, or post juvenile mortality. Therefore, long-term monitoring of heavy metal effect on the population of the Crested Murrelets is needed.

AS THE EGG TURNS: MONITORING EGG ATTENDANCE BEHAVIOR IN SEABIRDS USING NOVEL DATA LOGGING TECHNOLOGY

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Egg turning is unique to birds and critical for embryonic development in most avian species. Technology that can measure changes in egg orientation and temperature at fine temporal scales (1 Hz) was neither readily available nor small enough to fit into artificial eggs until recently. Here we show the utility of novel miniature data loggers equipped with 3-axis accelerometers, magnetometers and a temperature thermistor to study egg turning behavior in three seabird species. Artificial eggs containing egg loggers were deployed in 72 nests of Cassin's auklets (*Ptychoramphus aleuticus*; N = 35), Western gulls (*Larus occidentalis*; N = 17), and Laysan albatrosses (*Phoebastria immutabilis*; N = 20) for 1-7 days of continuous monitoring. The data collected by these egg loggers show that these species (1) turn their eggs frequently (up to 9 turns h⁻¹) and turns are most commonly at small angular changes (1-10°), (2) display similar mean turning rates (ca. 2 turns h⁻¹) despite differences in reproductive ecology, and (3) demonstrate distinct diurnal cycling in egg temperatures that varied by 1.4-2.4°C. These novel egg loggers revealed high resolution, 3-D egg turning behavior heretofore never seen in wild birds. This new form of biotechnology has broad applicability for addressing fundamental questions in avian breeding ecology, life history, and development, and can be used as a tool to monitor birds that are sensitive to disturbance while breeding.

RECENT DEVELOPMENTS IN INDUSTRY BIRD MONITORING PROGRAM FOR ALASKAN FREEZER-LONGLINERS

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An industry-supported program to monitor bird bycatch on Freezer-longliners fishing in Alaska has occurred continuously on all such vessels since 2001. Program elements currently include daily updates provided to each vessel/manager when its observer has reported a bird record; weekly “report cards” to the vessel captains and fleet managers; and semi-annual reports which include both numbers and rates of birds. A 2010 report (Dietrich and Fitzgerald) analyzed factors influencing seabird bycatch, and also recommended modification of the industry reporting system. I discuss recent modifications to the monitoring system: boat names rather than confidential codes are displayed; set (extrapolated) instead of sample numbers are used; and a summary is provided of albatross information including take location, for same time period in prior years. I describe changes to fleet activities following formation of a coop in 2011, including consolidation of the fleet, higher observer coverage and longer fishing seasons. I present updated bird incidental catch information for this fleet, for 2010-2012.

IMPACTS OF THE 2001 JESSICA OIL SPILL ON ENDEMIC AND NATIVE GALÁPAGOS BIRDS, REPTILES, AND MAMMALS

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Tanker Jessica grounded on Shiavioni reef, Wreck Bay, Isla San Cristóbal, Galápagos 16 January 2001. Forty-five percent of her 400,000 gallon cargo of fuel oil escaped into the Galápagos Marine Reserve. Environmental contamination was broadly, but thinly, dispersed throughout the southern and western archipelago. Partial shorelines of Islas Fernandina, Isabela, Floreana, Santa Fé, Santa Cruz, San Cristóbal, and Española were fouled. One hundred and forty-five endemic marine iguanas (*Amblyrhynchus cristatus*), 116 native brown pelicans (*Pelecanus occidentalis*), 79 endemic sea lions (*Zalophus wolfebaeki*) and 8 native green sea turtles (*Chelonia mydas*) accounted for 94% of 370 non-piscine vertebrates directly affected. Nine additional species of native and endemic birds made up the remaining 6%. Endemic Galapagos penguins and flightless cormorants, initially predicted to be extremely vulnerable, escaped direct impacts due to their distributions within the archipelago and the pattern of fuel oil dispersal.

FLEXIBLE FORAGING BEHAVIOUR IN MASKED BOOBIES ACCORDING TO FORAGING LOCATIONS AND ENVIRONMENTAL CONDITIONS

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The ability of an animal to adjust its foraging behaviour and to detect, feed and move optimally within and among prey patches, are central questions in ecology. Prey patch quality and encounter rates were assessed by measuring the number of dives within a dive bout and distances between bouts, respectively, in masked boobies *Sula dactylatra*, during the chick-rearing phase at Phillip Island (South-west Pacific), Australia. We examined how these parameters changed over time (two early breeding phases and one late phase over two years) and according to specific foraging locations visited by the birds and environmental conditions. Masked boobies foraged in two distinct areas: over a nearby shallow shelf ("local area") and over distant deeper waters ("distant area"). Birds showed strong foraging site fidelity within the local area between trips and throughout the study, suggesting predictable prey encounters, but not elsewhere. Although prey encounters were predictable, prey patches were of lower quality within the local area, as indicated by smaller dive bout size. In the distant area, prey patches were of higher quality, but distances between bouts more variable, indicating less predictable prey encounters. Masked boobies adjusted their foraging behaviour within a short time period according to the foraging locations and environmental conditions. Local trips are likely to ensure that chicks are fed more frequently, but the yield of these trips appears to be insufficient for adults to maintain their own body reserves during unfavourable periods, leading adults to forage on higher quality prey patches in more distant waters.

DISTRIBUTION AND ANNUAL MOVEMENTS OF THE IVORY GULL (*PAGOPHILA EBURNEA*) IN THE CANADIAN ARCTIC

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The ivory gull (*Pagophila eburnea*) is an endangered seabird which spends its entire year in the Canadian Arctic environment. Breeding range is estimated to span the Canadian Arctic in the North Atlantic and Arctic Oceans, where ivory gulls require specialized but simple nesting habitat. Threats from various sources including illegal shooting and exposure to contaminants are

thought to have contributed to a decline in numbers (80%) since the 1980s. Due to the remote habitats of these birds and the corresponding challenges of observing and tracking them, we know little of their migration patterns and behaviour. Moreover, no multi-year research on movement and habitat use has been conducted in Canada.

As outlined in the Canadian ivory gull recovery strategy, information on annual movements is critical to obtain information of where and when they move as well as how they use these sites during breeding and non-breeding seasons. In 2010, satellite transmitters were attached to 12 ivory gulls on Seymour Island, NU (76.8° N, 101.3° W). To date, up to four breeding seasons of tracking data have been collected on these individuals, providing 50 277 useable, georeferenced locations for analysis. Using maps produced with Geographic Information Systems (GIS), we present the first evidence describing the annual movements and distribution of a subpopulation of the Canadian ivory gulls. Our results are consistent with predictions based on earlier banding or observational work, while some results of the current study markedly change our perception of ivory gull behaviour and migration.

CLIMATE CHANGE AND THE NEXUS BETWEEN BOTTOM-UP AND TOP-DOWN CONTROL IN AN OCEAN ECOSYSTEM: AN UNCOMMON CASE OF TOO MANY FISH IN THE SEA

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Climate change in the last century was associated with spectacular growth of many wild Pacific salmon stocks in the North Pacific Ocean and Bering Sea, apparently through bottom up forcing linking meteorology to ocean physics, water temperature, and plankton production. One species in particular, pink salmon, became so numerous by the 1990s that they began to dominate other species of salmon for prey resources and to exert top down control in the open ocean ecosystem. Information from long-term monitoring of seabirds in the Aleutian Islands and Bering Sea reveals that the sphere of influence of pink salmon is much larger than previously known. Seabirds, pink salmon, other species of salmon, and by extension other higher order predators, are tightly linked ecologically and must be included in international management and conservation policies for sustaining all species that compete for common, finite resource pools. These data further emphasize that the unique two-year cycle in abundance of pink salmon can be viewed as one end of the frequency spectrum of “regime shifts” and “tipping points”—that is, it drives interannual shifts between two alternate states of a complex marine ecosystem.

AGE MATTERS? INFLUENCE OF MANAGEMENT PRACTICES ON AGE-SPECIFIC COLONY ARRIVAL DATES AND AGE DISTRIBUTION IN CASPIAN TERNS

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We investigated colony arrival dates and age distributions of Caspian terns (*Hydroprogne caspia*) based on color-banded individuals re-sighted at three breeding colonies in the Pacific Northwest: (1) a very large colony in the Columbia River estuary where tern nesting habitat has been reduced to mitigate predation impacts on ESA-listed salmonid smolts by terns, (2) a newly established colony at an alternative nesting island provided as part of the management, and (3) a colony not subjected to management. Average colony arrival dates of young adults (3-4 years old) at the managed colony were significantly later in the third year of intense habitat reduction, up to 45 days later, compared to pre-habitat reduction. There was no such delay in colony arrival for older terns at the managed colony or for young adults at the unmanaged colony during the same time period. The average colony arrival dates in young adults at the newly established colony was significantly earlier, 31 days earlier in 3-year old terns, than at the managed colony, while there was no difference in arrival dates between the colonies in older adults. There were also more young adults at the newly established colony than expected compared to the unmanaged colony. At the newly established colony, terns without a previous breeding history were more susceptible to nest failure during incubation period than terns with a previous breeding history or older adults. These results suggest that newly available nesting sites may attract more young adults, and age distribution skewed towards young adults should be considered as a potential limiting factor for colony size and productivity.

DEVELOPING PRACTICAL SOLUTIONS TO REDUCE DISTURBANCE TO SEABIRDS, SHOREBIRDS AND WATERFOWL THROUGH STAKEHOLDER PARTICIPATION

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Lack of understanding is one of the challenges of addressing disturbance to breeding seabird colonies. Ultimately, individuals are not aware that their actions can negatively impact marine wildlife. In July 2013, the Seabird Protection Network and Gulf of the Farallones National Marine Sanctuary hosted a Waterbird Disturbance Symposium.

The Symposium offered a unique opportunity for an open dialogue among all stakeholders, including boaters, kayakers, pilots, biologist, marine educators, and local, state, and federal

resource managers. The Symposium was a platform to initiate collaborations and develop partnerships as we move forward in fostering leaders of waterbird stewardship. We gained stakeholder perspectives, learned about success stories and identified ways stakeholders can share information with their constituents.

The Seabird Protection Network (the Network) is a multi-organization collaborative that aims to restore and protect seabird populations harmed by the 1998 Command Oil Spill and the Luckenbach mystery spill. Restoration funds from these spills are being used to address one of the biggest obstacles to the recovery of seabird populations: human disturbances. The goal of the Network is to reduce human disturbances at seabird breeding and roosting sites along the California coast. Increased public awareness, coupled with coordinated management, enforcement and strategic partnerships, is essential to effectively protect seabirds from negative human interactions.

MARINE PREDATORS AS TERRESTRIAL PREY: COULD A CLIMATE-DRIVEN TERRESTRIAL RESOURCE PULSE LEAD TO HYPERPREDATION OF A THREATENED SEABIRD BY NATIVE PREDATORS?

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The largest breeding population of Scripps's Murrelets (*Synthliboramphus scrippsi*) in California, USA is on Santa Barbara Island, where nesting birds face threats from native predators including the Barn Owl (*Tyto alba*) as well as an endemic subspecies of deer mouse (*Peromyscus maniculatus elusus*) that consumes murrelet eggs. Deer mice are also important prey for owls, therefore the aim of this study was to investigate how Barn Owl predation on murrelets varies with the availability of rodent prey and with space use of owls. First, we confirm the links between an ENSO-driven rainfall pulse, terrestrial productivity, and the subsequent increase and then sharp decline in mouse and owl numbers on the island from 2010 to 2013. Secondly, we evaluate evidence for prey switching in Barn Owls (through pellets and prey remains) as well as the space use of owls in relation to mouse densities. Track tube indices consistently showed greater mouse activity in murrelet nesting areas than habitats in the interior of the island, and owls were also more frequently detected on line transects adjacent to murrelet habitat. This pattern of space use generally persisted regardless of the availability of seabirds as prey. However, there were substantial differences in the number of murrelets killed by owls among years. Our results are consistent with the alternative prey hypothesis and suggest that the terrestrial resource pulse dynamics could lead to short-term hyperpredation on murrelets. We discuss the implications of a climate-driven impact on a seabird mediated through terrestrial

pathways, as well as the potential for positive indirect effects of owls through predation on murrelet egg predators.

EFFECTS OF OCEANOGRAPHIC VARIABILITY ON THE REPRODUCTIVE SUCCESS AND HABITAT USE OF LAYSAN AND BLACK-FOOTED ALBATROSSES

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The reproductive success of Laysan (*Phoebastria immutabilis*) and Black-footed (*P. nigripes*) albatrosses breeding in the Northwest Hawaiian Islands has shown considerable variation over the past 30 years, with marked declines occurring concurrently in both species in certain years. To assess the effects of oceanographic change on albatross reproduction, we examined a 30-year time series of reproductive success in relation to inter-annual variability in the location of the Transition Zone Chlorophyll Front (TZCF), as well as Multivariate El-Nino Southern Oscillation Index (MEI); Northern Oscillation Index (NOI); Pacific Decadal Oscillation (PDO); and North Pacific Gyre Oscillation (NPGO). We evaluated time-lagged effects of these variables, and used Principal Components Analysis (PCA) to examine how albatross reproductive success was influenced by oceanographic change. We evaluated the foraging movements of both species during the incubation and brooding periods in relation to variability in the TZCF. Satellite tags deployed during the brooding period from 2003-2012 were used to evaluate at-sea habitat use. Trip duration and distance travelled were higher in years when the TZCF was farther north (i.e., farther away from the nesting site), suggesting an increased energetic cost during the most constraining time period in breeding. The first PCA axis reflected changes in the location of the TZCF, while the second PCA axis represented broad-scale climatic indices; the first two PCA axes explained 79% and 77% of the variation in Laysan and black-footed albatross reproductive success, respectively. We discuss our findings in relation to both observed and predicted oceanographic change in the North Pacific.

DISTRIBUTION OF TAHITI PETREL AND HERALD PETREL ON TA'U ISLAND, AMERICAN SAMOA

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The Tahiti petrel (*Pseudobulweria rostrata*) and Herald petrel (*Pterodroma heraldica*) are tropical petrels about which little is known. These petrels breed on many islands throughout the South Pacific, including the island of Ta'u in American Samoa. Ta'u is a heavily forested high volcanic island, west of Tutuila on which petrels nest in the summit montane region. Although the petrels on Ta'u have been documented and investigated in the past, very little is known about their current abundance and distribution. We surveyed the summit region to identify the presence of petrels using night time acoustic playback surveys and remote acoustic recorders. Petrels were found in low abundance throughout the habitat with more calls identified on the western side of the summit region than on the eastern side of the summit region. The overall low abundance of petrels relative to reports from the 1990's and 2000's indicate that the populations on Ta'u may have experienced significant declines. However, further research on the populations is needed to identify accurate population numbers and seasonal variation. Further monitoring is being carried out to determine the status of the populations and the potential threats.

ACOUSTIC DETECTIONS OF AVIAN POWER LINE COLLISIONS: A NOVEL MONITORING SOLUTION FOR A GLOBAL PROBLEM

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Power line collisions are a threat to birds worldwide, with annual strike estimates in the 100's of millions. Quantifying collision rates is difficult despite being a vital metric required to identify lines that pose a threat. In Hawaii, endangered seabird species are of particular concern, with birds colliding with lines at night when they fly to montane breeding colonies from the sea. Strike rate estimates for these species have so far been based on the number of carcasses found under lines. However, carcass counts are limited by unsearchable habitat under lines due to steep terrain, thick vegetation and remote locations. In addition, ground searching for carcasses is ineffective at quantifying 'wounding' bias, where birds collide with lines but continue to fly on. We tested the effectiveness of passive acoustic sensors (song meters) as a tool for detecting and quantifying the sound of power line collisions by placing acoustic sensors at the base of power poles during two seabird breeding seasons. To validate the technique, observers monitored bird

collisions with power lines using night vision and near-IR lights. The sounds of strikes heard by observers were also linked to audio files to ascertain whether they were recorded by the sensors. After 811 hours of nocturnal seabird monitoring we visually and/or aurally recorded 58 strikes, including 12 where the collision was actually seen. We report the reliability of acoustic devices for recording the sound of a bird striking power lines and the effectiveness of computer analysis for detecting strike sounds on audio files. Finally, we discuss the broader application for acoustic monitoring of avian power line collisions

THE DIET OF NORTHERN FULMARS, *FULMARIS GLACIALIS*, IN THE EASTERN BERING SEA AND ALEUTIAN ISLANDS REGION: AN EXERCISE IN THE USE OF BY-CAUGHT MARINE BIRDS IN INVESTIGATIONS OF NATURAL FEEDING STRATEGY

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Stomach contents were analyzed from 631 Northern fulmars, *Fulmaris glacialis*, collected from fisheries by-catch in the eastern Bering Sea and Aleutian Islands region during the years 2008 – 2012. Food items obtained from local fisheries sources and from the natural environment were readily identifiable and were treated separately in the analyses. Food items representing 17 species scavenged from fisheries sources were present in 473 samples with an overall frequency of occurrence (FO) of 75.0 %. Of these, three species utilized as bait in the longline fisheries; Argentine short-fin squid, *Illex argentinus*, Pacific saury, *Cololabis saira*, and Pacific herring, *Clupea pallasii*, were the most common with a collective FO of 76.7 %. The remaining 14 species had a collective FO of 59.2 % and were scavenged from trawl fisheries by-catch (offal). Naturally occurring prey representing 33 species were present in 553 samples with an overall FO of 87.6 %. Twenty-one species of mesopelagic squid made up the bulk of the naturally occurring diet with an overall frequency by number of 90.1 % in 100 % of the samples. Fishes played a minor role in the natural diet with a frequency by number of only 1.6 % with an FO of only 6.0 %. Prey size estimates utilizing cephalopod beaks, fish bone, and otolith measurements were conducted and naturally occurring prey species were classified based on known age-related depth distribution. These data revealed most (82 % by number) of the mesopelagic squid species were from dead or moribund adults that were scavenged at the surface. Evidence of direct predation on live juvenile fishes, squid, and crustaceans at the surface occurred in only 32.4% of the samples.

POPULATION STATUS OF JAPANESE MURRELETS (*SYNTHLIBORAMPHUS WUMIZUSUME*) AT BIROJIMA, JAPAN, IN 2011-2013

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In 2011-2013, the Japanese Murrelet Population Survey Team of the Japan Seabird Group (funded by Suntory Group) reassessed the status of Japanese Murrelet (*Synthliboramphus wumizusume*) at Birojima, the largest known colony of this rare and endangered alcid last examined in the mid 1990s. We conducted nocturnal spotlight surveys and night-lighting captures of murrelets attending at-sea congregations near Birojima (2011-2012), as well as nest monitoring and rat trapping (2013). In late April 2011, eight family groups departing Birojima, many hatched eggshells in nesting areas, relatively low counts, and limited surveys indicated that delayed spotlight surveys were inadequate for estimating population size. In early April 2012, extrapolation of highest radial and round-island survey densities yielded 2,507 murrelets in congregations around the island (about 1,200-1,800 pairs), similar to the 1994 pre-dusk peak count of about 2,221 murrelets in congregations on the south side (about 1,000-1,500 pairs). High hatching success (79%, n = 38) was evident in 2013, with abandonment accounting for most clutch failures (88%, n = 8). Evidence of predation on eggs and adults was found, probably mainly by Jungle Crow (*Corvus macrorhynchos*), Carrion Crow (*C. corone*) and Ural Owl (*Strix uralensis*), but much higher predation was noted in 1994. Rat feces were not observed and no rats were caught during extensive trapping in 2013. High population size, high hatching success, and low predation indicated a healthy colony at Birojima in 2011-2013. Standardized methodologies and baseline data at Birojima in 2011-2013 allow for long-term trend monitoring and comparisons to other colonies.

LONGEVITY AND DISPERSION OF REHABILITATED SEABIRDS AND WATERFOWL, 1980 – 2010: PRELIMINARY DATA FROM OILED BIRD BAND RETURNS

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Since its founding after the Arizona and Oregon Standard oil spill in San Francisco Bay in 1971, International Bird Rescue (IBR) has been at the forefront of treatment and release of oiled animals in more than 200 events worldwide. Since 1980, all birds treated and released by IBR in California and during specific events in Oregon, Washington, and Louisiana have been banded with federal bands issued by the USGS Bird Banding Laboratory. As part of IBR's long term partnership with California's Oiled Wildlife Care Network, oiled birds rehabilitated during California events before and including the Dubai Star spill in 2009 were banded with IBR bands, although specific events have occasionally had another entity providing bands. As part of a study comparing band encounter data from oiled and rehabilitated birds released 1980-2010 to non-oiled rehabilitated conspecifics and wild conspecifics banded for other reasons, 237 records of live and dead encounters with banded formerly oiled birds have been identified thus far, representing 31 species. Records comprise 51 alive encounters, 178 dead, and 8 unknown condition reports. Birds were banded and released after treatment for oiling a mean of 531 days before alive encounters (SD = 599.5, median = 305, range = 2 - 2846 days). Dead encounters occurred a mean of 339 days after banding (SD = 614.9, median = 50, range = 0 - 3777 days). Twenty-seven birds encountered dead were shot, four birds were found dead on roads/highways, and one re-entered care alive due to botulism.

MARINE DISTRIBUTION OF SEABIRDS IN THE EASTERN CANADIAN ARCTIC: THEN AND NOW

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Climate change is causing rapid changes in Arctic marine ecosystems and the decline in sea ice will open waterways to increased vessel traffic and development. The waters of the Canadian Arctic support millions of seabirds, and studying the patterns and processes of their at-sea distribution and abundance can identify critical habitats, provide a better understanding of marine ecosystem functioning and help to monitor the impacts of climatic and anthropogenic changes. Using vessel-based survey data spanning six decades (1965-1992 and 2006-2013) we

examined changes in the summer distribution and abundance of seabirds in the eastern Canadian Arctic (sub-arctic waters around Newfoundland north to Barrow Strait, Nunavut). Over six decades, Lancaster Sound, Baffin Bay, Davis Strait and the waters off Labrador and Newfoundland have consistently supported high densities of seabirds such as northern fulmar (*Fulmarus glacialis*), black-legged kittiwake (*Rissa tridactyla*), and thick-billed murre (*Uria lomvia*) in the summer. Davis Strait and Baffin Bay were important marine areas for dovekie (*Alle alle*) both currently and in the past. Recent surveys found high densities of kittiwakes and murrelets in Lancaster Sound in July but past surveys show higher densities there in August. At a broad-scale, marine distribution of Arctic seabirds has remained similar over the past six decades, although some changes in range extent and temporal variability of important marine areas are evident. Linking decadal changes of seabird distribution to changes in ice thickness and extent may provide some indication of future important areas previously unavailable due to year-round ice coverage.

INTER-COLONY DIFFERENCES IN THE INCUBATION PATTERN OF STREAKED SHEARWATERS IN RELATION TO THE LOCAL MARINE ENVIRONMENT

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Foraging trip duration for breeding seabirds is affected by the characteristics of the available feeding habitat, which might, in turn, generate inter-colony difference in the patterns of nest attendance. Here, nest attendance patterns and foraging areas used by Streaked Shearwaters, *Calonectris leucomelas*, during their incubation period were examined using global location sensors. The study was conducted at Sangan (SI) and Mikura Islands (MI) in the northwestern Pacific, and Awa Island (AI) in the Japan Sea during 2006-2009. The duration of incubation shifts showed significant inter-colony difference, but no sex-related difference. Shearwaters from SI had shorter mean incubation shifts (5.6 days on average; range 3.0-8.0 days) than those from MI (7.2 days; range 4.8-10.7 days) and AI (6.9 days; range 6.0-9.7 days). During the incubation period, SI and MI shearwaters foraged in the northwestern Pacific's Kuroshio-Oyashio transition area, while shearwaters from AI mostly foraged in the Japan Sea. The Northwestern Pacific represents a high-productivity zone, and SI shearwaters appeared to forage in these waters, where foraging efficiency is potentially high, leading to shorter incubation shifts. Also, although MI shearwaters foraged in the northwestern Pacific, the distance between their colony and

foraging areas was greater (645 km on average; range 546-756 km), compared with SI (272 km; range 244-297 km) and AI birds (228 km; range 75-518 km). In this study, inter-colony differences in incubation shift duration for Streaked Shearwaters appears to be related to differences in foraging areas associated with the local marine environment.

WINTERING AREA AND MERCURY IN THE FEATHER OF SHORT-TAILED SHEARWATER

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Human impacts in the offshore ecosystem have been a recent concern, but its monitoring is logistically difficult. Seabirds accumulate marine pollutants in their tissues and bring back these to the colony. We tracked year-round movements of short-tailed shearwaters (*Puffinus tenuirostris*), that breed in Tasmania and spend non-breeding period in northern North Pacific, using geolocators in 2009-2011 and analyzed the relationships between individual ranges and the mercury (Hg) content in their breast and primary feathers. During non-breeding period (May – Sep), 20 birds used western North Pacific (WEST), 14 used eastern North Pacific (EAST) and 6 used both (MIX). Hg concentrations of the breast feathers (1.6 ppm), which were replaced during late breeding period, were low as those of primary feathers, which were replaced during non-breeding period. Hg concentration of the primary feathers of WEST birds (2.4 ppm) was higher than MIX (1.2 ppm) and EAST birds (0.8 ppm). Nitrogen stable isotope ratio, as a proxy of trophic level, of the primary feather was high for some EAST birds and did not affect mercury contents. This indicates that WEST birds were exposed to higher mercury pollution than EAST birds.

PLANNING FOR KAUAI'S FIRST PREDATOR PROOF FENCE AT KILAUEA POINT NATIONAL WILDLIFE REFUGE

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Newell's Shearwaters are listed as threatened under the Endangered Species Act and nest almost exclusively on the island of Kaua'i, where the population is thought to be less than 15,000 breeding pairs and is declining due to habitat degradation, predation by introduced species, and collisions with man-made structures. As such, plans are underway to install a predator-proof fence near Crater Hill at Kilauea Point National Wildlife Refuge to serve as a translocation site for Newell's Shearwater and to protect existing populations of native birds. An intensive ecosystem monitoring program focusing on birds, plants, invertebrates and predators is underway with the objectives to determine species present (plant and animal; native and non-native) and their seasonal abundance in order to determine how to most effectively remove the predators, and how native species respond to their removal. Information is also being gathered on Newell's Shearwaters to develop translocation protocols and determine source colonies for chicks that will ultimately be translocated. Outreach will be conducted to solicit community input on the project as it progresses. This project comes at a critical juncture for Kauai's seabirds with the recent confirmation of mongooses, and when completed in 2014, will be the first predator-free seabird nesting areas on Kaua'i.

ECOSYSTEM-BASED MANAGEMENT IN ALASKA: THE ROLE OF SEABIRDS AS INDICATORS OF ECOSYSTEM CHANGE

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The marine waters of Alaska's Exclusive Economic Zone encompass four distinct ecosystems: the Arctic, eastern Bering Sea, Aleutian Islands, and the Gulf of Alaska. Commercial groundfish fisheries are active within the latter three ecosystems and are of great importance to the United States' economy, contributing \$1.05 billion USD in 2012 in the price of fish alone. These fisheries are also of great conservation interest due to the potential direct and indirect effects on marine ecosystems. In the US, ecosystem-based management was declared a national priority under the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 and the 2011 National Ocean Policy. How these new national policies inform or change existing regional fisheries management is an evolving process and varies by jurisdiction. In

Alaska, the groundfish fisheries are managed by the North Pacific Fisheries Management Council. This Council's objectives are to maintain predator-prey relationships and energy flow, maintain diversity, maintain habitat, and incorporate/monitor effects of climate change. Identifying suitable ecosystem indicators to monitor over time and in relation to management actions is one way to meet the Council's objectives. Seabirds-as-indicators is a long-standing discussion, both in the literature and among members of the Pacific Seabird Group. In Alaska, seabirds are currently used as indicators to measure some of the direct ecosystem impacts of fisheries by monitoring seabird bycatch, and are increasingly being included in a broader context through monitoring demography and foraging. In this presentation, I'll discuss ecosystem indicators in Alaska and the ways that seabirds currently inform the fisheries management process. I'll also suggest ways that seabirds could further inform managers in the evolving process of ecosystem-based management.

VARIABLES THAT CAN AFFECT OF OIL-AFFECTED SEABIRD SURVIVAL BEFORE, DURING, AND AFTER THE REHABILITATION PROCESS

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Large-scale impacts of oil spills to seabirds have been regularly reported over the past century. These effects have caused widespread morbidity and mortality in affected animals at an individual level and, arguably, at population levels in certain circumstances. Recently, large-scale wildlife responses worldwide have been mounted by professional animal care organizations, leading to opportunities to provide input into developing improvements in the knowledge and understanding of the effects of oil on wildlife, as well as methods to better care for affected animals. Research and information gathered to date has focused on a number of different fronts, primarily aimed at understanding the effects of oil on wildlife at a physiological level as it relates to survival both during rehabilitation as well as after release. Therefore, the purpose of this presentation is to review these advances in rehabilitation and diagnostic techniques of oiled birds, with particular emphasis on those biomedical and husbandry methods that have produced both positive as well as negative effects on survivability in oiled seabirds.

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