

## PSG 2013 PORTLAND ABSTRACTS

### CONSERVATION IMPLICATIONS OF PINK-FOOTED SHEARWATER (*PUFFINUS CREATOPUS*) MOVEMENTS AND FISHERY INTERACTIONS OFF SOUTH AMERICA ASSESSED USING MULTIPLE METHODS

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Approximately 60,000 pink-footed shearwaters (PFSH, *Puffinus creatopus*) breed on three islands off Chile and undertake trans-equatorial migrations to foraging grounds off the Pacific coasts of Central America, Mexico, USA, and Canada. Known anthropogenic threats at their breeding colonies include chick harvesting, depredation by introduced species, and habitat degradation. To better understand threats at sea related to fisheries off South America, we determined the movements of satellite-tracked PFSH in relation to geographic and political boundaries and movements through known fishing grounds. PFSH interact with fisheries in Chile, Peru, and Ecuador; our measured distribution of satellite-tracked PFSH off South America indicates potential risk for bycatch with multiple fisheries. In addition, rapid assessment surveys at 13 Chilean ports yielded an estimated annual bycatch and subsequent mortality of 1,384 and *ca.* 1000 PFSH, respectively. Tracking revealed fine-scale coastal movements of the species and its affinity with waters over the continental shelf and shelf-break shared also by numerous fisheries that use gillnets and purse-seines. The Peruvian Port of Salaverry driftnet fishery had the greatest overlap with PFSH and observers in this fishery documented a PFSH bycatch rate of 0.004 PFSH set<sup>-1</sup>. Given the size of the Peruvian gillnet fleet (*ca.* 3000 vessels, 80,000+ trips annually)—this catch rate could result in considerable total catch. Several options for future actions include, additional monitoring, additional observer effort off central-northern Peru, assessments of risks with purse-seiners off Chile and Peru, and artisanal fisheries off Central America and Mexico.

### IMPORTANT MARINE HABITAT AREAS FOR MIGRATORY BIRDS IN EASTERN CANADA

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Marine birds are integral components of marine ecosystems, relying upon and spending critical portions of their existence within them. Eastern Canada and adjacent waters of the Northwest Atlantic host important quantities of marine birds, in terms of diversity and proportions of species' populations.

Assessment of landscape-level marine habitat and species distribution and abundance information, and related identification of important areas and information gaps, can enhance marine spatial planning processes, leading to more informed integrated management, protected area network design, and effective marine ecosystem conservation.

We examined seabird at-sea and colony data gathered from 1965 to 2011. We used simple spatial representation tools to identify and highlight locations where important aggregations were observed at sea, at and in the vicinity of colonies, hence areas where they might be most vulnerable. Specifically, we

identified important marine areas for individual species and species guilds by generating effort-corrected relative abundance maps derived from at-sea monitoring data using a 5X5 km grid, kernel density estimation and colony buffers derived from studies of breeding season foraging range.

We mapped these data independently of behaviour, interannual or seasonal variation. Further analyses will aim to assess hotspot persistence, elucidate mechanisms underlying patterns of variation, leading to enhanced understanding, as well as possible avenues for interpolation. These steps are consistent with ongoing efforts by the Government of Canada to inform identification of Ecologically and Biologically Significant Areas, integrated management, and design of national and bioregional marine protected area networks, in anticipation of broader marine spatial planning needs.

#### LONG-TERM VARIABILITY IN NESTING EFFORT AND REPRODUCTION OF THE CALIFORNIA BROWN PELICAN IN THE GULF OF CALIFORNIA: A FOUR-DECADE PERSPECTIVE

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The Brown Pelican is amongst the more adaptable of the coastal-nesting seabird species. In the past, El Niño/Southern Oscillation (ENSO) influence on breeding population size and reproductive performance in the California Brown Pelican (*Pelecanus occidentalis californicus*) meta-population has been highly variable from year-to-year, although other factors such as long windy and cold periods during the breeding season, disturbances, contaminants, and habitat loss or degradation, also impinge upon population performance. Yet, oceanographic features and feeding conditions associated with ENSO drive most normal variability in nesting effort and productivity. The total meta-population is estimated at about  $71,000 \pm 2,600$  breeding pairs (Mean  $\pm$  SD) in optimal, non-ENSO years; the total numbers within this meta-population was estimated at  $196,000 \pm 7,200$  individuals (including sub-adults and non-breeders). In ENSO years, the numbers of breeding pairs and reproductive success are much less. Based on detailed data from several important breeding colonies in the Midriff Region of the Gulf, annual numbers of breeding pairs and their productivity might drop to near zero during years of ENSO-effect. A life-table model incorporating ENSO's varying effects on survival and reproduction indicates that under current demographic parameters, increased frequencies and/or intensities of ENSOs expected effects might likely result in population declines and/or range shifts. There is now credible data from the literature indicating increased frequency and intensity of ENSO events associated with climate change. We need another 40+ years of monitoring!

## EGG-LAYING BEHAVIOR IN GLAUCOUS-WINGED GULLS

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Various aspects of reproductive biology of Glaucous-winged gulls (*Larus glaucesens*) have been evaluated. Egg laying behavior has not yet been documented. We modified digital spy-cameras to monitor nests continuously during daylight hours. During labor, females stood or crouched over their nest for an average of 4.8 minutes. An average of 27 visible contractions occurred with maximum rates of 15.3 contractions/min during hard labor. During labor the wings were slightly spread and the abdomen was held close to the ground in a crouched position. After laying, females stood over the nest for an average of 8.9 min, which was followed by turning the egg and sitting on the egg. Three of the females vocalized during labor. This consisted of very short (50-100 ms) single or doublets of syllables having a fundamental frequency 900 kHz. Two females gathered small amounts of nest material and placed it on their backs while sitting on their nests prior to labor, and one did so while incubating after laying. Although eggs were laid throughout the day and night, there was a significant difference in when the eggs were laid. The loss of eggs (mostly cannibalized) also varied significantly. Poisson regression showed that day of the year and solar elevation were predictors of egg laying, whereas tide height, time of day, and occupancy were not. Egg losses increases with day of year and tide height, but not time of day, solar elevation or occupancy.

## EVALUATING THE SUCCESS OF NEWLY RESTORED CASPIAN TERN BREEDING HABITAT IN MALHEUR NATIONAL WILDLIFE REFUGE, OREGON

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We evaluated an effort to restore Caspian Terns (*Hydroprogne caspia*) to Malheur National Wildlife Refuge (NWR) in eastern Oregon, where intermittent availability of secure island nesting habitat (due to fluctuating water levels) has limited tern nesting in the past. Prior to the 2012 breeding season, the U.S. Army Corps of Engineers constructed a 0.4-ha rock core island in Malheur Lake, within Malheur NWR, specifically for Caspian Terns. Caspian Tern decoys and automated sound systems playing tern vocalizations were installed on the island in mid-April, and Caspian Terns were observed investigating the island the same day. The first nesting was confirmed in early May and ultimately 232 pairs of Caspian Terns nested on the new island, producing 195 fledged young (0.84 fledglings/breeding pair). Caspian Terns previously banded at other colonies throughout Washington, Oregon, and California were observed at the new island and during the post-breeding dispersal period over 1,000 terns regularly used the island as a nighttime roost. A number of banded Caspian Terns initiated nesting at the new island after being observed nesting (and presumably failing) elsewhere within the Pacific Northwest in 2012; some terns were still actively nesting at the Malheur tern island in October. Tern diet consisted predominantly of tui chub (*Gila bicolor*; 54% of identified prey items) and juvenile common carp (*Cyprinus carpio*; 30%). High water levels in 2011 and 2012 presumably led to abundant cohorts of juvenile fish and contributed to the success of the Caspian Tern restoration effort in 2012; future prey abundance is uncertain.

## DEMOGRAPHICS OF ALBATROSSES CAUGHT AS BYCATCH IN HAWAIIAN (2010-2012) AND ALASKAN LONGLINE FISHERIES (2007, 2009-2011)

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To inform seabird bycatch population and distribution models we investigated demographics of albatrosses bycaught in commercial Hawaii pelagic longline fisheries (2010-2012) and Alaska demersal longline fisheries (2007, 2009-2011). We compared demographic parameters based on age class, sex, and body condition. Characteristics used to assign age class included plumage and maturity of ova, oviduct, testes, and Bursa of Fabricius. We quantified body condition for birds based on a combined scoring of subcutaneous and intestinal fat stores, and development of the pectoral muscle complex. In total we examined 278 albatrosses, including 119 Laysan Albatross (*Phoebastria immutabilis*) and 78 Black-footed Albatrosses (*Phoebastria nigripes*) from Hawaii fisheries, and 62 Laysan Albatross and 19 Black-footed Albatross from Alaska fisheries. Over 98% of individuals of both species had no bursas, indicating that both Hawaii and Alaska fisheries are predominately catching older pre-breeding to breeding-age albatrosses. In Hawaii fisheries, one third of Laysan (33%; n=18) and Black-footed (35%, n=16) females were reproductively mature. Sex ratios were equal except for a significant male bias in Laysan Albatross mortality in the Alaska fisheries (89% male). In all fisheries, both species exhibited strong body condition (70-100% were in good-excellent body condition). We suggest continued collection and examination of bycatch seabirds to document demographic trends to inform population- level modeling with regard to mitigation and conservation status.

## TEMPORAL TRENDS IN MARBLED MURRELET ABUNDANCE IN CANADA (1996-2011) BASED ON RADAR COUNTS

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The Marbled Murrelet (*Brachyramphus marmoratus*) is a small Pacific seabird listed as ‘Threatened’ in Canada by the Species at Risk Act. The species is an unusual seabird because it nests solitarily at low densities on moss covered branches of old growth trees, up to 30 km from the ocean. The cause for listing is loss of old growth forest nesting habitats. We report the population trend of the Marbled Murrelet in Canada based on a statistically powerful monitoring program which uses marine radar to detect birds as they enter the forests. Population trends were assessed with time series data from 876 dawn surveys at 59 radar monitoring stations within the six Marbled Murrelet Conservation Regions of British Columbia. Population trends of the Marbled Murrelet were analyzed with a mixed model approach which controlled for variation in radar tilt and day of year, and random terms for station nested in region, observer, make and type of radar units, and study area-wide year effects. A non-significant trend indicates a stable population between 1996 and 2010 for the study region as a whole. The Conservation Region on the East Coast of Vancouver Island showed a decline from 2003-2011.

## IMPACT OF BALD EAGLES ON NESTING DOUBLE-CRESTED CORMORANTS AT THE LARGE COLONY ON EAST SAND ISLAND IN THE COLUMBIA RIVER ESTUARY

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The largest colony of Double-crested Cormorants (*Phalacrocorax auritus*) in western North America, on East Sand Island (ESI), Oregon, experienced intense disturbance by Bald Eagles (*Haliaeetus leucocephalus*) during the 2011 and 2012 breeding seasons. During the 2012 breeding season, eagles were observed on or near the cormorant colony during >80% of bi-hourly scans. Eagles caused nesting cormorants to flush frequently, about once per hour, and often killed adult cormorants and depredated nests. Although the mean proportion of the colony disturbed was just 3%, flushes were of sufficient duration (mean=2.6 min) for Western/Glaucous-winged Gulls (*Larus occidentalis* x *L. glaucescens*) to also depredate cormorant nest contents. Despite this, the peak colony size remained stable at ~12,000 breeding pairs. Nesting success, however, was ~1.3 fledglings/pair in both years, 40% below the 2004-2010 average. Although cormorant productivity clearly suffered at ESI in 2011 and 2012, the colony was more resilient to eagle disturbance than other seabird colonies in the region. Cormorants at ESI may benefit from both large colony size and dispersed nesting across a large area. In particular, discreet sub-colonies can fail individually without complete colony collapse. The increased impact of eagles in 2011-12 may be due to eagle behavioral changes perhaps related to diminished alternative prey opportunities. A 2012 pilot study to investigate management techniques to restrict cormorant nesting habitat caused greater spatial overlap between cormorants and eagles and may have contributed to greater eagle impacts. It is unclear whether the heightened level of eagle disturbance will prevent long-term persistence of this colony.

## NOT JUST NOISE: EXPLORING SOUNDSCAPES OF SEABIRD COLONIES

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Many seabirds are heavily reliant on acoustic signals, and colonies possess unique soundscapes that contain biologically relevant information about individuals, populations and resources. Advances in electronics, telecommunications and automated pattern analysis create the possibility of using soundscapes to study remote seabird colonies in new ways and at unprecedented scales. Studying soundscapes allows managers to inexpensively monitor elusive populations, enables restorationists to enhance colonization and measure success, and gives evolutionary biologists insight into the diversity and form of seabird communication. New data collection and interpretation tools have increased the number of ecological questions to be asked, but validation of acoustic indices has been limited, and little attention has been paid to the patterns and interactions of acoustic signals on seabird colonies. Here we present three new tools for exploring seabird colony soundscapes: 1) a spatially explicit simulation tool for composing varied colony soundscapes with the manipulation of individuals, density, species, and added noise, 2) an approach to visualizing colony soundscapes at seasonal scales, incorporating relevant diel cycles, and 3) a complementary spectral rather than call/template-specific approach to analyzing colony soundscapes. We use simulations and empirical data to identify potential biases in acoustic indices such as colony spatial dispersion and noise masking. Using spectral analysis and new visualization tools we compare and contrast seabird colony soundscapes within and across taxa, with an ear towards soundscape organization, acoustic adaptation, and monitoring.



## RESTORING SEABIRDS ON THE BAJA CALIFORNIA PACIFIC ISLANDS

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The Montrose Settlements Restoration Program was developed in 2001 to oversee restoration of natural resources harmed by DDT and PCBs in the Southern California Bight. One of the Montrose restoration projects aims to restore seabird populations on Coronado and Todos Santos Islands, two island groups located off northwestern Baja California. These islands support a diverse group of breeding seabirds and are known for their high levels of biological diversity. The target seabird species for restoration include the Cassin's Auklet (*Ptychoramphus aleuticus*), Brandt's Cormorant (*Phalacrocorax penicillatus*), California Brown Pelican (*Pelecanus occidentalis*), Ashy Storm-Petrel (*Oceanodroma homochroa*), and Scripps's Murrelet (*Synthliboramphus scrippsi*). A partnership comprised of the National Audubon Society, Cornell Lab of Ornithology, Grupo de Ecología y Conservación de Islas (GECI), and the Mexican Fund for the Conservation of Nature will implement the 5-7 year seabird restoration program. This partnership will strengthen an on-going successful conservation program conducted by GECI and the Government of Mexico on these islands over the past 15 years. Restoration activities will include social attraction, habitat restoration, reduction in human disturbance, and environmental education. Improvement of nesting grounds on these islands will create more stable and viable populations of seabirds in both the United States and Mexico.

## USE OF A DIVING PROCELLARIIFORM, THE SOOTY SHEARWATER, TO EXPAND A MARINE PLASTIC BIODINDICATOR NETWORK

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There is growing recognition that plastic pollution in our oceans has reached a critical level and must be addressed. Seabirds, especially procellariiforms, have proven to be a useful bioindicator of marine plastic debris through the monitoring of their ingestion habits. To date, most efforts in documenting procellariiform ingestion of plastic have focused on primarily surface-foraging species. There is reason to suspect, however, that pursuit diving species may not reflect the same plastic ingestion patterns. In this study, we examined the stomach contents of Sooty Shearwaters (*Puffinus griseus*), a species that uses both surface seizing and pursuit diving to forage. We collected samples from 26 birds from the northern Oregon/southern Washington region to quantify the frequency of occurrence, abundance, color and size of plastics in the diet. Plastic was found in 69% (18 out of 26) of specimens, which is lower than incidences of plastics in Fulmar stomachs. The abundance, color and size of plastics found in the Shearwaters will also be presented. Due to the differing feeding habits in Shearwaters versus Fulmars, it was expected that plastic categorizations would produce different results in the two species for amounts and types of plastics found. If our hope is to create a comprehensive network of seabird bioindicators of plastic debris then our knowledge base must be expanded to species that reflect a wide variety of foraging guilds, as they are likely to provide unique insights into the marine plastic issue.

## NEST-HABITAT PARTITIONING AND SHARING AMONG BURROW-NESTING SEABIRD SPECIES ON RECENTLY RAT-FREE ISLANDS IN NEW ZEALAND

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New Zealand has the world's highest diversity of burrow-nesting seabirds. Since human colonization, safe nesting habitat has been limited for these birds, as most breeding islands were occupied by introduced predators, particularly rats. Recently, rat eradication has occurred on many invaded islands, thus restoring safe breeding space. To assess how habitat selection, and competition or facilitation between species will affect the recovery of burrow-nesting seabird colonies after eradication we compared nesting habitat use of five Procellariiform species among four offshore islands recently designated rat-free, a rat un-invaded, and an island with rats in northern New Zealand. We assessed nesting habitat selection by comparing burrow density and occupancy with a suite of factors including soil type, aspect, elevation, slope, and vegetation. We hypothesized that nesting habitat selection would differ between islands with different predator histories; with birds only occupying habitat where they were less vulnerable or could swamp predation on islands with less time since eradication. We found a positive relationship between years since eradication and proportion of available habitat used for nesting. Burrow density was much lower in poor habitat (areas with shallow and hard soil and low slope) on islands where rats had been removed recently ( $0.04 \pm 0.05$  burrows/m<sup>2</sup>) versus islands with no rats or rats eradicated more than 20 years ago ( $0.63 \pm 0.40$  burrows/m<sup>2</sup>). We found more habitat separation between large and small petrel species on islands with less time since eradication; suggesting that body size may influence spatio-temporal patterns in recovery after predator eradication.

## IMPROVING BURROWING SEABIRD HABITAT WITH NATIVE PLANT RESTORATION AND SEA LION EXCLUSION: RESULTS FROM AÑO NUEVO ISLAND, CALIFORNIA.

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Restoration of nesting habitat for burrowing seabirds was conducted on Año Nuevo Island in 2010-2012 to mitigate mortalities from oiling events and from extensive habitat alterations during past human use. Over 14,000 native grasses and shrubs were planted on the previously denuded colony, with the goal of halting burrow erosion and associated reproductive failure of Rhinoceros Auklets (*Cerorhinca monocerata*) and Cassin's Auklets (*Ptychoramphus aleuticus*). In addition, an innovative fence called a Habitat Ridge was installed to prevent extreme episodic trampling by sea lions. Vegetation cover, burrow damage, and auklet population metrics were quantified before and after restoration. Prior to plant installation in 2010, total vegetation cover in restoration plots was 0-15%, and all remnant plant species were exotic. By fall 2012, total vegetation cover in restoration plots ranged from 15-79%, with 98% of vegetation composed of native species. Annual numbers of burrows severely damaged by erosion ranged from 37-61% prior to restoration (1998 – 2001), and after restoration dropped to 3% and 6% in 2011 and 2012, respectively. The Rhinoceros Auklet population has remained stable, averaging 240 birds since the year 2000. An estimated 270 Rhinoceros Auklets bred on the island in 2012, with 84% of nests in the protected restoration area. Cassin's Auklets colonized the island in the 1990's and their population grew to an estimated 74 breeding birds in 2012, with 22% of nests in the restoration area. Our results demonstrate that burrowing seabird habitat can be successfully stabilized by restoring a native plant community and preventing trampling events.

## MARINE SPATIAL PLANNING IN THE US: FROM NATIONAL POLICY TO LOCAL PLANNING

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Coastal and Marine Spatial Planning (CMSP) is a comprehensive public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives. In 2010, President Barak Obama signed an Executive Order declaring a new national policy on oceans for the United States. The Executive Order also laid out a framework for Coastal and Marine Spatial Planning and required federal government agencies to begin the planning process within U.S. waters. To date, CMSP has begun in several regions (New England, Mid-Atlantic) and states (e.g. Rhode Island, Oregon, Washington).

A common first step in the CMSP process is collecting and organizing existing data on infrastructure, natural resources, species, and human activities. The information is then converted into an online portal or database so stakeholders can access and view the data. Seabird data has been incorporated into these efforts but a challenge remains about how to consider the nesting and foraging needs of seabird in the planning and zoning discussions.

This presentation will provide an overview of the U.S. CMSP framework, actions happening in the regions and states, and describe why the seabird community should get involved and contribute to the process.

## SET-BACK DISTANCES TO PROTECT NESTING AND ROOSTING SEABIRDS ON VANCOUVER ISLAND FROM BOAT DISTURBANCE

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With increasing recreational boat traffic worldwide, there is a need for scientifically based regulations that sustain both seabirds and wildlife viewing. The effects of boat disturbance to seabirds off Vancouver Island, Canada were quantified by testing distances that roosting or nesting birds showed an agitation response to an approaching motorboat or a kayak. The effects of species sensitivity, vessel type, habituation and the season on agitation distance were examined. At 40 m from approaching boats, nesting Double-crested (*Phalacrocorax auritus*) and Pelagic cormorants (*P. pelagicus*), Black Oystercatchers (*Haematopus bachmanii*), Glaucous-winged Gulls (*Larus glaucescens*), and Pigeon Guillemots (*Cepphus columba*) had less than 6% probability of being agitated with either a kayak or motorboat, while at 50 m there was less than 2% probability of agitation. Roosting birds had larger response distances than nesting birds. Roosting Harlequin Ducks (*Histrionicus histrionicus*) were particularly sensitive with 24% probability of agitation at distances less than 50 m. Agitation distances were reduced by habituation to boat traffic and a single kayak could approach closer than a motorboat without disturbing seabirds. A general set-back guideline of 50 m would protect most nest and roost sites while allowing viewers to appreciate seabirds. Set-backs could be adjusted to protect locally sensitive sites or species.



## THE PERILS OF PERSISTENCE: PATTERNS OF DECLINE AT THE WORLD'S LARGEST CASPIAN TERN COLONY

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Nest site fidelity is presumed to enhance reproductive success of colonial seabirds, but can be a liability if habitat suitability declines or predators target nesting colonies. The Caspian Tern (*Hydroprogne caspia*) colony on East Sand Island (ESI), Columbia River estuary is the largest in the world, supporting ca. 9,500 breeding pairs. Active since 1999, the colony has experienced a significant increase in rates of both kleptoparasitism ( $P=0.04$ ) and nest predation ( $P=0.01$ ) by gulls (*Larus* spp.). Additionally, the ESI tern colony has experienced a decline in reproductive success that is inversely-related to Columbia River volume during the breeding season ( $P=0.01$ ). The Corps of Engineers has incrementally reduced the size of the ESI tern colony since 2008 to improve survival of out-migrating juvenile salmonids. In 2010, severe storms caused nest loss and contributed to unprecedented low reproductive success (0.05 fledglings/pair). From 2010 to 2011 there were reductions in both fidelity to individual nest sites and retention of neighbors, coincident with a 35% reduction in available nesting habitat. During late incubation in 2011, the advent of Bald Eagle (*Haliaeetus leucocephalus*) predation on adult terns at the nest, coupled with intense egg predation by gulls, resulted in total colony failure. After colony failure, terns displaced by habitat reduction were significantly more likely to remain at ESI and continue re-nesting attempts than were non-displaced terns ( $P=0.01$ ). Despite multiple stressors and availability of alternative colony sites, terns exhibited high fidelity to this super-colony site in 2011 and 2012.

## ENGAGING LOCAL COMMUNITIES TO ADVANCE SEABIRD CONSERVATION: CASE STUDY OF A THREATENED CHILEAN ENDEMIC

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The complexity of seabird conservation can be even greater when local communities interact with focal species on their breeding grounds and/or at sea. Community participation in, and commitment to, conservation measures greatly enhance long-term chances of success and increase the likelihood that such initiatives will become self-sustaining. As a central part of our long-term conservation program for the threatened Pink-footed Shearwater (*Puffinus creatopus*), we have led community-based conservation efforts in the Juan Fernandez Islands and Isla Mocha, Chile, for 11 and 3 years, respectively. We have focused community-based efforts on two principal areas: (1) community awareness development through artistic, creative and educational activities and (2) capacity building and training of local residents. Using the Pink-footed Shearwater as a central theme, we have led a creative writing workshop and contest and a drawing competition, created active-learning modules for the local environmental education programs, invited a team of mural artists to work with schoolchildren and paint a mural for the school, and co-sponsored the "Shearwater Cup", a soccer tournament for island residents. More than 50% of students were involved in the mural painting, 10% in the creative writing and drawing contests, and 25% in interpretive colony visits. Our second focus, local capacity building, has produced teams of local residents (>20) trained and hired to work as field technicians and local coordinators on a variety of conservation, monitoring and restoration projects. Bottom-up community-based initiatives, using a suite of activities, have tremendous potential to complement on-the-ground conservation and restoration activities focused on threatened seabirds.

## USING STABLE ISOTOPES TO DETERMINE PREDATION OF ENDEMIC SEABIRDS IN THE JUAN FERNANDEZ ARCHIPELAGO, CHILE

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The impacts of introduced species on the native avifauna of oceanic islands have been well documented. However, population-level effects of predation by invasive mammals can be difficult to determine. Stable isotope analyses (SIA) provide a tool to quantitatively assess the importance of prey species in the diets of predators and, hence, gain insight into predation intensity. To evaluate predation by invasive mammals on the threatened seabird community of the Juan Fernandez Islands, Chile, we conducted stable carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotope analyses of feces from feral cats (*Felis catus*), muscle from rodents (*Mus musculus* and *Rattus norvegicus*) and blood samples from endemic seabirds (Pink-footed Shearwater *Puffinus creatopus*, Juan Fernandez Petrel *Pterodroma externa*, and Stejneger's Petrel *Pterodroma longirostris*). We complemented the SIA results with macroscopic analyses of cat feces. Rodents segregated into two isotopic groups on both islands, Robinson Crusoe and Alejandro Selkirk, with the stable carbon isotope values indicating a primarily terrestrial diet for mice ( $\delta^{13}\text{C} = -24.937 \pm 0.509$ ) and a possible weak marine signature in rats ( $\delta^{13}\text{C} = -22.862 \pm 1.917$ ). Feral cats had a terrestrial signature on Robinson Crusoe ( $\delta^{13}\text{C} = -24.664 \pm 3.016$ ) but a marine signature on Selkirk ( $-19.956 \pm 1.942$ ). Delta  $^{15}\text{N}$  values, coupled with the terrestrial signatures, did not indicate predation by rodents or cats on Pink-footed Shearwaters on Robinson Crusoe, although the cat sample size was small ( $n=10$ ). On Selkirk, however, comparisons of trophic levels ( $\delta^{15}\text{N}$ ) suggested predation by mice, rats and cats on Juan Fernandez and Stejneger's petrels, with the smaller Stejneger's petrel particularly vulnerable.

## RECENT RESEARCH AND ADVANCES IN RADAR TECHNOLOGY FOR THE STUDY OF MARBLED MURRELETS

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Marine radar techniques have been used to study Marbled Murrelets (*Brachyramphus marmoratus*) since the early 1990s, but there continue to be advances in the field. This talk provides an update on recent research and radar technology. In one recent study, radar techniques were used to study the inland distribution of murrelets in Northern California, indicating that murrelets generally do not use the drier habitats beyond the redwood-dominated habitat along the Pacific coast. Recent studies also have documented year-round patterns of inland flights, showing a reduction in flights during the nonbreeding season. In addition, radar techniques have been used to measure among-site and among-day variation in flight altitudes. Radar monitoring of local murrelet populations continues in the U.S. and Canada. Recent interest in development of wind energy facilities within the inland range of murrelets has led to several recent studies that used radar methods to assess collision risk of murrelets at those facilities. Associated studies have used radar methods to measure collision avoidance behavior of murrelets at manmade structures. In addition, automated radar systems have been tested to determine if they could be used as early-warning systems to reduce collisions with turbines. Lastly, a panel of experts has been convened to help the USFWS develop a survey protocol for radar studies of murrelets at proposed wind energy sites; an update on the current status of that protocol will be provided.

## IMPACT OF TIME OF DAY ON FLIGHT AND FORAGING PATTERNS OF LESSER BLACK-BACKED GULLS (*LARUS FUSCUS*) AT SEA

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Detailed knowledge of individual flight and foraging patterns of seabirds can help to indicate possible changes in the marine environment. Among wind and tides, time of day is assumed to affect flight activity and at-sea distribution of several seabird species. Previous studies indicating a clear correlation of time of day on the flight behaviour of seabirds primarily used data from standardized ship or plane based seabird surveys. As new, small GPS loggers yield extremely detailed information about flight and foraging paths of different seabird species, it is now possible to analyze such relationships for single individuals. This study aims to identify daytime rhythms in the flight patterns of logged lesser black-backed gulls (*Larus fuscus*). The lesser black-backed gull is a common breeding bird of the southern North Sea and classified as typical offshore species mainly feeding on swimming crabs and fishes. The poster will present some results of a logger study during incubation in 2012. At which time of day do lesser black-backed gulls forage? When do they rest or breed? Do they visit certain foraging areas to a certain time of day? To detect any effect of time of day on the flight and foraging patterns of the tagged lesser black-backed gulls different statistical models and several GIS methods are used. Furthermore, analyses of pellets and stable isotopes from blood samples collected at the breeding colonies during the logger period help to give a complete overview of the time budgets of lesser black-back gulls in the southern North Sea.

## NEW APPLICATIONS OF RADAR AND ACOUSTIC RECORDINGS FOR MONITORING *BRACHYRAMPHUS* MURRELETS

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We tested automated acoustic sampling on its own and in combination with marine radar as a new method for monitoring activities of marbled murrelets (*Brachyramphus marmoratus*). Autonomous acoustic sensors are a cost-effective alternative to audio-visual (AV) and radar surveys because they can be deployed without a field crew and at sites that are unsuitable for heavy radar equipment. We compared predawn detections by radar, AV, and Song Meter<sup>TM</sup> (SM) at 5 sites in the Kodiak Archipelago in 2011-2012 (13 dawn surveys), and selected one site where multiple sensors were deployed throughout the breeding season (250 h, 3800 detections). SM recordings were processed using recognition models developed in Song Scope<sup>TM</sup>. Despite differences in daily counts, there was no difference in weekly mean counts by AV and SM. Radar and SM detections were not correlated either across sites or within sites, because acoustic sensors did not detect silent commuting murrelets, while murrelets circling over possible nesting habitat inflated acoustic detections relative to radar counts. Nonetheless, continuous daily sampling with SMs showed clear seasonal patterns, and provided fine-scale spatial resolution of murrelet behaviour. Although acoustic sampling cannot provide absolute density estimates, it produces an index of abundance that can discriminate between high and low-traffic flight corridors, and patch-scale differences in murrelet habitat use (presence and occupancy). This level of resolution in murrelet habitat use is not possible from radar surveys alone. The integration of radar and acoustic sampling provides both reliable population estimates, and fine-scale resolution of habitat use by murrelets.

## CHARACTERIZING RHINOCEROS AUKLET (*CERORHINCA MONOCERATA*) GENETICS IN THE WESTERN UNITED STATES

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Determining population boundaries in seabirds assesses current population health and future recovery abilities from oiling events and bycatch. Alcids like Rhinoceros Auklets (*C. monocerata*) have reduced flying ability and site fidelity that limits gene flow between colonies. Lower genetic diversity in alcids indicates lack of gene flow between colonies and reduced potential for recovery. It is hypothesized that: 1) samples in the California would differ genetically from those in the rest of the Pacific; 2) samples collected in different years from the same site in Japan would not differ significantly; 3) winter beachcast birds in Monterey Bay will originate from Canada and summer beachcast birds from California. Blood samples were obtained from colonies on Año Nuevo (20) and Southeast Farallon Island (33) in California, Protection Island (20) in Washington, Teuri Island (55) in Japan, and genetic samples from Monterey Bay beachcast birds collected between 2005 and 2010 (40). Genetic sequences from Canada, Alaska, and Japan collected for another study were compared to the sequences for this study. Significant genetic differences were found between California birds and the rest of the Pacific colonies. No significant temporal differences were found in the samples from Japan. More beachcast birds found in Monterey Bay originated from Canada in winter than in summer. These data will be useful for future management of *C. monocerata* populations.

## OPTIMIZING MONITORING PROTOCOLS FOR DETECTING REGIONAL TRENDS IN LEDGE-NESTING SEABIRD POPULATIONS

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Kenai Fjords National Park has designated seabirds as species of management concern given their importance to local ecosystems, vulnerability to environmental change, and contribution to generating tourism for the park. Historical survey methods for assessing seabird populations in Kenai Fjords region have been inconsistent and have precluded quantitative assessment of changes in seabird abundance and temporal trends. Monitoring ledge-nesting seabird abundance and trends at a regional scale is a difficult undertaking, especially in the North Pacific where remote locations, rugged coastlines and highly variable weather conditions limit accessibility and greatly increase the costs associated with monitoring. Evaluating the efficacy of available monitoring methods is essential to ensuring that management goals are achievable (i.e. that a given accuracy is possible) and that costs are minimized. The overall goal of this study is to determine the most cost effective monitoring method and protocols for quantifying ledge-nesting seabird population trends on a regional scale. Using glaucous-winged gulls (*Larus glaucescens*) as a model species we will compare the efficacy of survey protocols, including the number of colonies surveyed, number of survey replicates and survey timing for three survey methods: boat-based observer counts, boat-based photographic counts and aerial photographic counts. We will apply the results to Kenai Fjord National Park management goals. We are currently analyzing data from 2012 and will continue data collection in 2013.

## DECADAL DECLINES IN MID-SUMMER ABUNDANCE OF *BRACHYRAMPHUS* MURRELETS IN PRINCE WILLIAM SOUND, ALASKA

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The Marbled Murrelet (*Brachyramphus marmoratus*) and the Kittlitz's Murrelet (*B. brevirostris*) are both species of conservation concern. We used mid-summer (July) boat-based marine bird surveys conducted in Prince William Sound (PWS), Alaska in 12 different years during 1989-2012 to assess changes in abundance of *Brachyramphus* murrelets. We asked two questions: (1) was there a trend in overall abundance of *Brachyramphus* murrelets, and (2) did trends in abundance differ among areas within PWS and, if so, were rates of change in different areas a function of mean abundance (i.e., were trends density-dependent). To estimate overall trends in abundance, we first generated population estimates for each survey year, and then estimated the trend over time using weighted nonlinear regression. To determine whether abundance trends differed among areas within PWS, and whether any such differences were density-dependent, we examined trends within transects using generalized linear mixed models. There was strong evidence of an overall decline in abundance of murrelets ( $P = 0.0005$ ). We estimated that the mean annual rate of population change ( $\lambda$ ) was 0.948 (95% CI: 0.929 to 0.968). Over the 23-year survey period, this corresponds to a 70.8% cumulative decrease in abundance (95% CI: 53.1% to 81.8%). The best-supported model indicated that murrelet abundance trends have differed among areas within PWS, but that trends were not density-dependent. Whether local ecological factors might be associated with differences in population trends among areas warrants further investigation. Our results also support continued concern about the population status of *Brachyramphus* murrelets in PWS.

## THE RESTORATION OF A SHORT-TAILED ALBATROSS COLONY ON MUKOJIMA, OGASAWARA ISLANDS GROUP

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Historically, breeding colonies of Short-tailed Albatross (*Phoebastria albatrus*; STAL) were broadly distributed in the northwestern Pacific islands. The species was driven to the brink of extinction by feather hunters and guano mining. Many years of conservation management activities have maintained a 7% year<sup>-1</sup> population increase, but the breeding colony is still restricted to two sites, Torishima Island and the Senkaku Islands, and neither of these sites are secure due to volcanic activity or political instability. To facilitate the recovery of this species by establishing at least one additional colony, a total of 70 post-guard phase chicks were translocated from Torishima to a safe, former site, Mukojima, in February 2008-2012 and hand-reared there for 100 days until fledging. Fledging success was 99% in all these 5 years. The number of days when hand-reared STAL from previous years or naturally-reared STAL from other natal colonies visited Mukojima during the chick-rearing period increased greatly over time; 14 days in 2009, 11 days in 2010, 49 days in 2011, 75 days in 2012. The number of individual hand- or naturally-reared STAL visiting Mukojima per day also increased. During 2011 to 2012, a remarkable 12 of 25 birds hand-reared between 2008 and 2009 returned at least once to Mukojima. One male bird hand-reared in 2008 first returned at 3 years old, paired with a naturally-reared bird at 4 years old and in November 2012 began incubating an egg. The results demonstrate rapid progress toward potential new colony establishment through translocation and hand-rearing of albatrosses.



## MARINE SPATIAL PLANNING FOR THE NORTH PACIFIC COAST OF CANADA

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Marine spatial planning is underway in British Columbia at multiple scales, involving many levels of government, and for many different marine objectives or issues. The Marine Planning Partnership for the North Pacific Coast (MaPP) is a collaborative planning process for coastal and marine areas from Campbell River to Haida Gwaii. MaPP is a partnership between the Province of British Columbia, the Coastal First Nations-Great Bear Initiative, the North Coast-Skeena First Nations Stewardship Society and the Nanwakolas Council, which includes 20 member First Nations. Marine plans are being developed for four sub-regions, including Haida Gwaii, North Coast, Central Coast and Northern Vancouver Island, and these plans build on existing First Nations plans and provincial priorities. MaPP is using an ecosystem-based management framework to develop outputs that address marine issues in the North Pacific Coast including cumulative effects, zoning, compatible uses, marine protected areas, and economic strategies. The MaPP spatial data inventory includes over 200 layers for ecological, human well-being and governance categories. In this presentation, we will provide a brief overview of the planning process and discuss how seabird and other marine data are and will be used to identify high priority conservation areas using Marxan, assess the vulnerability of ecosystems to marine pollution, and other planning outputs.

## THE IMPORTANCE OF SEABIRD COLONY DATABASES IN SEABIRD MANAGEMENT, RESEARCH, DAMAGE ASSESSMENT AND CONSERVATION

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The lack of a readily accessible seabird colony database was one of the issues that led James Bartonek to propose the formation of the Pacific Seabird Group in 1972. He had just completed writing the marine bird section of the Trans-Alaskan Pipeline Environmental Impact Statement, during which he had to contact marine ornithologists with knowledge of the status of seabird colonies on the assumed route of tankers from Prince William Sound to West Coast ports.

In the two decades after PSG's formation there were seabird colony catalogues published for three of the four West Coast states, but it was not until the development of the Internet and the digital archiving of seabird colony data that information on seabird colony censuses was readily available to interested parties. Information obtained on seabird colony censuses is some of the most readily quantifiable and point-specific information we have about seabirds and should play an important part in seabird management, research, damage assessment, and conservation. This is all the more true with the current online databases that allow regular updates and easy access, in a way that could not have been anticipated forty years ago.

Examples of ways in which seabird managers and researchers have utilized colony databases (both in the hardcopy and digital eras) demonstrate why seabird colony censusing needs to be considered a priority for those concerned with marine birds. North Pacific seabirds will encounter increasing threats in the next four decades and detailed and current information on their numbers is needed.

## SIGHT AND SALVAGE: PREPARING OBSERVERS FOR SEABIRD DUTIES AT SEA

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NOAA's Alaska Fisheries Science Center Groundfish Observer Program annually certifies approximately 500 observers who provide more than 37,000 data collection days. Observer Program staff train new and continuing observers (3-week or 4-day refresher, respectively) to sample fisheries catch and bycatch from five vessel/processing types (trawl, mothership, longline, pot, shoreside plants and processors). Seabird bycatch information is collected. Observer's seabird duties were developed in cooperation with the U.S. Fish and Wildlife Service, including requirements specified in the Short-tailed Albatross Biological Opinion. Observers report (a) sightings of live, Short-tailed Albatross, (b) mortalities of all Short-tailed albatross, (c) mortalities of all bird species within the catch sample, and (d) opportunistically: bird strikes, "storms", and other gear interactions. Seabird identification training is the critical element supporting these activities -- made challenging because most observers have no previous bird identification experience. In 2008, NOAA Fisheries partnered with the Coastal Observation and Seabird Survey Team (COASST) to overhaul the seabird portion of the observer training with the combined goal of targeting and motivating a novice audience and emphasizing evidence-based identification via diagnostic characters from observer photos. After initiation of the new training, 98% of identifications made at sea were correct to family level (85% to species-level). Desired accuracy is dependent on taxonomic level (albatross and fulmars to species, others to species groupings). With the goal of 100% accuracy to targeted taxonomic levels in 2012, we credit an audience-driven lecture format and personalized learning approach in the laboratory session for recent advances in data quality.

## CHARACTERIZING THE FORAGING AND POPULATION ECOLOGY OF STELLER'S JAYS IN REDWOOD FORESTS: IMPLICATIONS FOR THE CONSERVATION OF MARBLED MURRELETS

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In California, marbled murrelets (*Brachyramphus marmoratus*) are highly threatened due to the loss of old-growth redwood forests needed for nesting, as well as by nest predation resulting from expanding corvid populations in the state and federal parks that harbor remnant nest stands. Steller's jay (*Cyanocitta stelleri*) abundances are exceptionally high in and around park campgrounds due to human foods present in campgrounds. However, limited understanding of jay ecology and the spatial scale at which human-provided foods subsidize jay populations has hampered ongoing management efforts intended to reduce predation threats to marbled murrelets in the region. We conducted research from 2010 to 2012 to characterize the foraging and population ecology of Steller's jays in campgrounds and surrounding old-growth redwood forests in Big Basin Redwoods and Butano State Parks. We used radio-telemetry, banding, and stable isotope-based assessments of diet to determine the spatial scale at which human-provided foods subsidize jay populations and threaten the viability of murrelets. Results suggest that jays breeding in campgrounds also forage in surrounding murrelet nesting habitat and that jays breeding in interior forests commute to exploit human-derived foods in campgrounds. Stable isotope analyses conducted to date suggest that human-derived foods are evident in the diet of Steller's jays that maintain territories in campgrounds and in the diets of jays traveling between campsites and interior forests. Thus, during the breeding season, campgrounds appear to subsidize jay populations on a larger spatial scale than suggested by their size and by observational data.

## EFFECTS OF TIDAL CURRENTS ON MARINE BIRD DISTRIBUTION IN GLACIER BAY, ALASKA.

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In coastal areas, tidal currents may create eddies, upwellings and convergent fronts that tend to concentrate pelagic prey consumed by marine birds. Tidal fluctuations may also influence the distribution of benthic invertebrates and therefore control the distribution of benthic feeding predators. Owing to high temporal variability in bird distribution, and difficulties in resolving coastal marine currents at appropriate spatial scales, it has been difficult to determine the degree to which currents influence the distribution of marine birds. We carried out numerical simulations of the tidal flows in Glacier Bay, Alaska, to link depths and current velocities to the specific times and locations of marine bird observations from boat-based surveys conducted in June of 2000-2003. Logistic regression models comparing used and unused habitats indicated that the distribution of 10 of 15 common species examined was influenced by current speed, while the distribution of 11 species was associated with depth. Seven species were disproportionately associated with either tidal ebb ( $n=3$ ) or flood ( $n=4$ ). Surface feeding birds used habitats with the highest current speeds and the greatest depths. Benthic feeding species used habitats with the slowest currents and shallow depths. Pursuit diving birds used areas that tended to fall between surface and benthic foragers in both current speed and depth. Benthic feeders as a group were also associated with tidal ebbs, though none of the individual species associations were significant. Our findings demonstrate that tidal effects, including current speed can affect the selection of habitats used by marine bird species.

## MARBLED MURRELET CONSERVATION EFFORTS: TOO LITTLE BUT NOT TOO LATE

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The continuing decline of the Marbled Murrelet (*Brachyramphus marmoratus*) is evidence that conservation activities in the two decades since Endangered Species Act listing and protection under the Northwest Forest Plan have not been sufficient to reduce the primary threats to the murrelet and promote its recovery. We briefly review conservation actions undertaken for the murrelet since listing, identify current conservation needs, and highlight important tools and responsible parties for achieving these conservation goals. Nesting habitat protection from timber extraction is provided by (1) Late-Successional Reserves on federal lands under the Northwest Forest Plan; (2) take prohibitions, Habitat Conservation Plans, and critical habitat protection on federal, state, and private lands under the Endangered Species Act; and (3) state forest practice rules on state and private lands. However the ongoing loss and fragmentation of nesting habitat in California, Oregon, and Washington underscore conservation failures resulting from lack of enforcement. We provide examples of priorities for enforcement, review the potential for targeted habitat acquisitions, and discuss the need for a science-based review of “restoration” silvicultural practices that aim to accelerate old-growth characteristics. We discuss gains in marine habitat protection and needed actions to reduce threats from oil pollution and by-catch. Reductions in predation have been accomplished through trash control, corvid management, and public education, but ongoing unsustainable predation rates necessitate increased action, including reducing human activities in critical nesting habitat. Finally we suggest policy and conservation plan updates to meet recovery goals and the need for funding commitments for research, monitoring and conservation actions region-wide.

## INCUBATE OR EAT: PATTERNS IN DIFFERENTIAL NEST ATTENTIVENESS BY RED-NECKED PHALAROPES

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Uniparental incubators that rely on exogenous resources face a trade-off between time spent on the nest and time spent feeding. This trade-off is especially critical in arctic-breeding species where the incubating parent faces harsh conditions that increase both the cost of incubation and the consequences of leaving the nest unattended. The frequency and duration of incubation offbouts can be adjusted in response to temporal, environmental and internal factors, but these adjustments may have consequences for parental condition and embryo development. We followed 82 successful Red-necked Phalarope (*Phalaropus lobatus*) nests over two seasons, recording clutch characteristics, male morphometrics, and nest attendance, using temperature probes to record determine the amount of time males were present at the nest. Some early-season nests took up to 150% longer than others to hatch, but much less variation occurred in late-season nests. The difference in incubation length in early-season birds may reflect their incubation strategies: nests with less-attentive males appear to take longer to hatch. As extended incubation increases the nest's exposure to predation and requires a longer period of investment, this strategy may have negative fitness consequences. Males that take longer to incubate may be in poorer condition, and thus less able to cope with the energetic demands of colder conditions early in the season. Alternatively, males incubating late-season nests may avoid lengthening incubation periods to ensure sufficient time for chicks to fledge before migration. In either case, it appears that male phalaropes exhibit different incubation strategies, both among individuals and across the breeding season.

## THE MYSTERIOUSLY DISPERSIVE MIGRATION OF THE ATLANTIC PUFFIN

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Migratory navigation in pelagic seabirds has long remained mysterious because traditional study methods provide scant data, but a revolution in miniature tracking technology and novel computational techniques is now making it possible to study the detailed behaviour of individual seabirds all year round. Using archival light loggers, we have established a long-term tracking program to investigate migratory navigation in a key species of UK breeding seabirds, the Atlantic Puffin (*Fratercula arctica*). We realize a detailed study of the migration routes of individuals for up to 5 years, focusing on route fidelity and timing. We also investigate potential sex-specific or pair-specific effects on the puffins' migratory strategy.

The first results are intriguing. Puffin migration is dispersive, with individual birds showing remarkable diversity in overwintering destinations. Nevertheless, individuals are highly conserved in their routes and destinations. Furthermore, partners seem to follow similar routes, suggesting potential social interactions within pairs during the non-breeding season. These results cannot be explained by genetic or cultural inheritance of the migratory route, the two usual theories about navigational control of migration. Our study should not only be a crucial test of a novel theory of migratory navigation but should also bring invaluable information for conservation planning, since UK puffin populations are in decline.

## NORTHERN FULMARS (*FULMARIS GLACIALIS*) AS BIOINDICATORS OF ENDOCRINE DISRUPTING PLASTICIZERS IN THE MARINE SURFACE ENVIRONMENT

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Many phthalates used to synthesize plastics have been identified as endocrine disrupting chemicals (EDCs), with studies showing dramatic deleterious effects on a variety of species as a result of exposure to growing numbers of EDCs in the environment. The Northern Fulmar (*Fulmarus glacialis*) is an opportunistic seabird which inadvertently consumes plastics as it forages. Previous studies of Fulmars suggest that plastics are leaching EDCs into the bird's systems. We determined the percentage of plastics ingested by fulmars that contain EDCs. A collaboration with the Long Marine Research Lab allowed for geographic comparisons of EDC concentration intensities along the West Coast. The percentage of plastics in the diet of fulmars that contained plasticizers was below 3% in all tested regions. Plastic proportions in Alaska differed significantly from those in California and Washington. Our analyses confirmed that fulmars are effective bio-indicators of plastics in surface marine environments and that the surface waters in tested regions are not highly contaminated by plastics containing EDCs. EDC-containing plastics typically displayed negative buoyancy and sank in seawater and may be accumulating in benthic regions. The impacts of plastic ingestion may be a more significant source of contaminant uptake by seabird species than previously assumed. Additionally, there are physical consequences to species; plastics take up volume in the stomach reducing digestive capacity which blocks nutrient absorption.

## FIVE YEARS OF SEABIRD RESTORATION ON ASUNCIÓN AND SAN ROQUE ISLANDS, PACIFIC OCEAN, OFF THE BAJA CALIFORNIA PENINSULA, MEXICO

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A seabird social attraction project has been taking place since 2008 on Asunción (43 ha) and San Roque (37 ha) islands, part of El Vizcaíno Biosphere Reserve, off the Baja California peninsula, Mexico. Over 10 species of seabird used to nest on these islands. However, the presence of introduced cats and rats during decades decimated and, in some cases, extirpated seabird populations. With the eradication of invasive cats and rodents both islands became a safe habitat for birds to return. Therefore, a long-term restoration project was envisioned, and has been successfully implemented for five consecutive years. The project involves the use of social attraction systems, including Elegant Tern and Heermann's Gull decoys, vocalization playbacks powered by solar panels, mirrors, and monitoring of seabirds and land birds. Results are positive: Interactions of Elegant Tern with decoys have been recorded, as well as the presence of Heermann's Gull nests, next to the attraction systems; and the recolonization of Cassin's Auklet (*Ptychoramphus aleuticus*) and Brown Pelicans (*Pelecanus occidentalis*) has been confirmed. Simultaneously, an environmental education program was applied on Bahía Asuncion, the nearest local community. The project involves collaboration between Mexican government agencies, donors and local fishing communities. The data gathered and the experience set the basis to integrate a much wider and long-term restoration program on the other Mexican Pacific islands, from Coronado islands in the North to Asunción in the South, which will benefit seabird populations distributed along the wide US-Mexico ecoregion.



## ESTIMATES OF SEABIRD BYCATCH IN ALASKAN GROUND FISH FISHERIES USING THE ALASKA REGION CATCH ACCOUNTING SYSTEM, 2007-2011

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NOAA's Alaska Fisheries Science Center fisheries observers have been recording seabird bycatch information in detail since 1993. Annual estimates of total seabird bycatch in Alaskan groundfish fisheries has provided valuable information for conservation and management. In 2009 the Alaska Fisheries Science Center held a workshop to address rare-event fisheries bycatch issues. A recommendation was made that seabird bycatch estimates be generated using the Alaska Region Catch Accounting System (CAS). Results from the CAS match well with previous methods used and have now been adopted as the standard tool for generation of estimates. With this system we can report seabird bycatch estimates for species or species groups by statistical area, region, target fishery, and time period. During the 2007-2011 reporting period, estimates of total bycatch have ranged from 4,596 to 10,441 birds. Albatross bycatch exhibits inter-annual variability in the total numbers and relative take by species. In 2007 and 2011 Black-footed Albatross (*Phoebastria nigripes*) was higher than Laysan Albatross (*Phoebastria immutabilis*) while Laysan Albatross bycatch was higher in other years. Total estimated take for Short-tailed albatross (*Phoebastria albatrus*) was 20 (15 in 2010 and 5 in 2011). The most common species taken was Northern Fulmar (*Fulmaris glacialis*), averaging > 50% of the bycatch (from 2,357 to 6,214 birds). The cod freezer longline fishery has the highest total bycatch while the sablefish fishery tends to have higher albatross numbers. Trawl fisheries generally have much lower bycatch numbers although total mortality of birds is difficult to estimate due to the gear interaction issues.

## HUMAN DISTURBANCE TO COMMON MURRE (*URIA AALGE*) BREEDING COLONIES ON THE CENTRAL CALIFORNIA COAST

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Human disturbance was monitored at six Common Murre (*Uria aalge*) colonies in central California in 2005-2012. This monitoring program informed an outreach and regulatory portion of the program (Seabird Protection Network) with the goal of reducing human disturbance to seabirds. Disturbance was categorized as: agitation, displacement or flushing of murre. Detections of potential sources of disturbance were also recorded regardless of disturbance to seabirds. Annual disturbance rates were calculated as the number of disturbances per observer hour at each colony and were compared to baseline averages of the first two years (2005 and 2006) of Seabird Protection Network outreach efforts. The sources of most disturbances were aircraft and boats. Disturbance rates from 2005-2012 varied among colonies (0.012 to 0.079 total disturbances per observer hour) but were highest at the recently restored murre colony at Devil's Slide Rock. Fixed-wing aircraft were detected most frequently and caused the greatest number of disturbances. However, helicopters elicited more disturbances proportional to detections, especially flushing. Boat-caused disturbances decreased at every colony from 2005 to 2012. Conversely, the aircraft disturbance in 2012 at Devil's Slide Rock was the greatest since 2005. From 2005 to 2012,  $397 \pm 114$  murre were flushed or displaced by human disturbance at Devil's Slide Rock each year, of which 63% resulted from helicopters. Disturbance assessment allowed for directed outreach to target likely disturbance sources and influenced regulations to reduce disturbance.

## EXPERIMENTAL ASSESSMENT OF TASTE AVERSION CONDITIONING ON STELLER'S JAYS TO PROVIDE SHORT-TERM REDUCTION IN EGG-PREDATION RISK FOR MARBLED MURRELETS IN NORTHERN CALIFORNIA

Pia O. Gabriel and Richard T. Golightly\*, Department of Wildlife, Humboldt State University, Arcata, CA, 95521 USA, [rtg1@humboldt.edu](mailto:rtg1@humboldt.edu) In recent years, Steller's jays (*Cyanocitta stelleri*) have contributed significantly to the poor nest success of marbled murrelets (*Brachyramphus marmoratus*). In California, murrelet populations continue to decline despite protection of almost all their habitat; reducing predation risk is an urgent management need. Predator behavior can be modified to avoid rare food items by methods known as conditioned taste aversion (CTA). We developed and tested a protocol to use CTA induced by an emetic added to murrelet-mimic eggs. The emetic Carbachol effectively produced aversions in jays without long-term ill effects when provided at a low dosage (24 mg/egg; 0.77 mg/g of egg). Experimentally determined retention of the aversion exceeded the testing period (8 weeks). In the field, we evaluated the effectiveness of aversion conditioning on resident jays within 428 ha of old-growth forest in California. After CTA application in the field, mimic eggs were less likely to be predated than paired control eggs ( $p < 0.001$ ). Predation by corvids on murrelet-mimic eggs decreased by 37-72% after CTA. Consequently a CTA strategy may be a cost effective method to provide short-term reduction in corvid predation on murrelet eggs and provide an additional tool for managers.

## NEW NEIGHBORS: CHANGES IN THE MARINE-BIRD COMMUNITY OVER THE PAST 35 YEARS

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Summer ice cover in the Arctic Ocean reached the lowest minimal extent on record in 2012. This decline is anticipated to have repercussions on the trophic structure in this environment, and there are indications that changes already have taken place in the marine-bird community. We quantified sea-ice cover and compared boat-based survey data collected in the Chukchi Sea during 1975–1981 (historical data) with surveys conducted during 2007–2012 (recent data) to explore how the marine-bird community may be responding to changes in the physical and biological oceanography of the Chukchi Sea. When compared with conditions 30 years ago, sea ice now forms later, melts earlier, and melts completely in all parts of the Chukchi Sea. Historical data indicate that the marine-bird community was composed primarily of piscivorous Black-legged Kittiwakes (*Rissa tridactyla*) and murrelets (*Uria* spp.). In contrast, recent data suggest that the marine-bird community in the Chukchi Sea is composed now primarily of seabirds such as Crested Auklets (*Aethia cristatella*) and Short-tailed Shearwaters (*Puffinus tenuirostris*), both species that prey primarily on euphausiids when they are available. New marine-bird species also have been added to the community in the past 10 years, including four species that were first recorded north of Bering Strait in 2006. Earlier ice retreat may contribute to an environment that is more amenable to euphausiid production. We propose that the changes in the abundance and composition of the marine-bird community reflect an increase in the abundance of large zooplankton prey in the region.

## SEABIRDS AND MARINE SPATIAL PLANNING: A NORTH SEA PERSPECTIVE

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Marine Spatial Planning in the European Union is based on various Directives, most importantly the Strategic Environmental Assessment Directive released in 2001. In this talk, we will give an example of the current status of Marine Spatial Planning in German North Sea waters, one of the most intensively used marine areas in the world. Various types of human activities (pressures) of the sea areas in both the Exclusive Economic Zone (EEZ) and territorial waters exist and partly overlap. We will describe the most important pressures (e.g. offshore wind farms, ship traffic, fishing) and their spatial demands, but also the current situation of marine protected areas.

The possible impact on seabirds is currently investigated for various human pressures. Extensive data sets on seabird distribution are available from ship-based and aerial surveys and have already frequently been used in the context of Marine Spatial Planning. E.g., distributional data have formed the basis for the establishment of Special Protection Areas according to the EU Birds Directive in the offshore areas. We will show how offshore wind farms, ship traffic and ground and set-net fisheries may impact seabirds and how these information can be aggregated to provide tools for marine Spatial Planning.

Finally, the implementation of seabirds in the set of indicators to be developed for meeting the requirements of the Marine Strategy Framework Directive will briefly be presented.

## MODELLING FORAGING RANGE FOR BREEDING COLONIES OF THICK-BILLED MURRES *URIA LOMVIA*

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There is substantial evidence that large seabird colonies reduce the availability of food in adjacent waters, creating a zone known as “Ashmole’s Halo”. Given the existence of the halo, Central Place Foraging theory (CPF) allows us to make some predictions about the distribution of food and birds at different distances from the colony. Using a time-budget approach and a CPF framework, we modeled the relationships between food density, foraging range and colony size for Thick-billed Murre colonies in Eastern Canada and tested these predictions against foraging trip distances recorded by GPS loggers attached to incubating birds at two colonies differing in size by an order of magnitude. Our results support the general predictions of CPF and allow us to predict maximum foraging ranges for Canadian Eastern Arctic colonies, enabling us to map likely zones of overlap between the foraging of breeding birds and future developments in Canadian Arctic marine waters.

## TIMELAPSE PHOTOGRAPHY REVEALS GREAT FRIGATEBIRD CHICK-REARING BEHAVIORS

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Monitoring seabird behaviors and reproductive effort and success at remote colonies can be difficult and time-consuming. Basic behaviors such as feeding frequency and interactions with chicks are not well-documented in many species. We combined timelapse photography with free open source firmware, CHDK, to monitor the frequency of nest-visits and chick-feeding behaviors by great frigatebird (*Fregata minor*) parents rearing chicks 4-8 months old on Tern Island, Northwestern Hawaiian Islands, during October-December 2012. Using this program, we monitored a total of 45 nests for approximately ten hours per day for up to 24 days each. We also monitored 32 of these nests during the six nights surrounding a full moon. Peak nest-visiting times occurred at 0700-1000 and again at 1600-1930, although great frigatebird parents did not visit their nests on a predictable daily or weekly schedule; the number of nest-visits was also not dependent on chick age. Only five percent of nest-visits occurred during nighttime on nights surrounding a full moon, indicating that parents generally do not feed chicks at night. Females made significantly more nest-visits than males, suggesting that like other species of frigatebird, great frigatebird males decrease chick-rearing effort in order to breed for two consecutive seasons, while females continue to feed the chick for up to one year. In addition to documenting previously unknown chick-rearing behaviors, the timelapse program allowed us to collect hundreds of hours of nest monitoring data remotely, demonstrating that open-source firmware and photography can be used for large scale behavioral studies in remote seabird colonies.

## MARINE PREDATOR DIETS AND VARIABLE OCEANOGRAPHIC CONDITIONS: IMPLICATIONS FOR FOOD WEB DYNAMICS AND ECOSYSTEM INDICATORS

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Variable ocean conditions can greatly impact lower trophic level prey assemblages in marine ecosystems, with effects propagating up to higher trophic levels. Our goal was to better understand how varying ocean conditions influence niche overlap among a suite of low- to mid- trophic level predators and evaluate predator diets as a method to track prey communities. We employed opportunistic fish diet collections in collaboration with commercial and recreational fishermen together with synoptic observations of a major seabird colony to determine the diets of four predator species on the central Oregon coast during two years of contrasting El Niño (2010) vs. La Niña (2011) conditions. The greatest degree of dietary overlap was observed between Chinook salmon (*Oncorhynchus tshawytscha*) and common murre (*Uria aalge*), with both smelts (Osmeridae) and clupeids (primarily *Clupea pallasii*) observed as the dominant prey types. Diets differed between El Niño and La Niña conditions for two predators, murre and black rockfish (*Sebastes melanops*). During La Niña, smelts decreased, while sand lance (*Ammodytes hexapterus*) increased in common murre diets. Black rockfish had fewer larval Dungeness crabs (*Cancer magister*) and a greater proportion of other crab species associated with the later spring transition. In contrast, Chinook salmon and Pacific halibut (*Hippoglossus stenolepis*) diets were similar during El Niño and La Niña conditions. Using multiple predators across several diverse taxa to track changes in prey communities provided a way to detect seemingly subtle changes in prey communities and can contribute to more comprehensive understanding of food web dynamics and ecosystem indicators.

## SPACE USE AND BEHAVIOR OF STELLER'S JAY IN CAMPGROUND AND NON-CAMPGROUND SITES WITHIN REDWOOD NATIONAL AND STATE PARKS

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Predation of eggs and chicks by Steller's Jays (*Cyanocitta stelleri*) and Common Ravens (*Corvus corax*) is considered a primary threat to the persistence of Marbled Murrelet (*Brachyramphus marmoratus*) populations nesting in California. We used radiotelemetry to simultaneously monitor Steller's Jays at campground sites and at non-campground sites within Redwood National and State Parks (RNSP) to provide baseline information on their space use and behavior during the Marbled Murrelet breeding season. Home range size at campground sites ( $16.0 \pm 2.5$  ha) did not differ from non-campground sites ( $13.6 \pm 1.9$  ha), but home range overlap was significantly higher at campground sites resulting in considerably higher densities of jays in and adjacent to campgrounds. At campground sites, there was a positive association between home range size and roost distance from the campground center, as individuals roosted and nested up to 1 km outside campground boundaries. Steller's Jays at campground sites spent more time perching and were observed on the ground significantly more than individuals at non-campground sites. Use of the low (0-10 m), mid (10- 30 m) and upper (>30 m) vertical forest canopy levels did not differ between campground and non-campground sites. Our results suggest that campgrounds in RNSP attract and concentrate the activity of adult Steller's Jays from outside campground boundaries and likely expose Marbled Murrelets nesting within and adjacent to campgrounds to increased nest predation risk. Management that greatly reduces or eliminates the availability of anthropogenic food at campgrounds may help reduce Steller's Jays activity at these sites.

## GULL-BILLED TERN-MEDIATED INTRAGUILD PREDATION IN SAN DIEGO BAY: USING RADIO TELEMETRY AND STABLE ISOTOPE ANALYSIS TO MEASURE CRYPTIC PREDATION EVENTS

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Western Gull-billed terns (*Gelochelidon nilotica vanrossemi*) are dietary generalists which habitat switch and forage at multiple trophic levels. They are the only known coastal tern species to prey upon terrestrial vertebrates, e.g. various species of lizards and the young of coastal nesting birds. In 2010, we initiated a project to investigate foraging movements and diet of Gull-billed Terns nesting in San Diego to determine the proportion of both Western Snowy Plover and California Least Tern chicks in the Gull-billed Tern adult and chick diet. Using spatial analyses and Bayesian mixing models, we were able to 1) document inter- and intra-annual variation in home range, 2) document differential predation risk for particular breeding bird locations within San Diego, and 3) model the diet of both adult females and chicks using stable isotope analysis.

Movement analysis suggests Gull-billed Tern home ranges are influenced by both bottom up processes affecting both marine and terrestrial food resources and by the increased energetic demands of raising chicks, signaled by changes in home range size and diet both inter- and intra-annually. While California Least Tern colony attendance by Gull-billed Terns was documented to be far greater than anticipated by purely visual observation, the diet modeling suggests that California Least Terns and Western Snowy Plovers make up less than 10% proportion of the Gull-billed Tern diet per year. Our results support the combined use of telemetry and stable isotopes to explore the potential impacts of hard-to-measure predation events.



## SOLAR-POWERED SATELLITE TELEMETRY AND GULL-BILLED TERNS: PRELIMINARY RESULTS OF POST BREEDING DISPERSAL AND WINTERING MOVEMENTS IN MEXICO

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Animal movement studies have long provided critical information for conservation planning, particularly for migratory species with complex conservation requirements. The increasing miniaturization of telemetry devices has enabled the collection of larger, more accurate and longer term datasets on the spatial behaviors of free-ranging wildlife that would normally be difficult to observe directly in the wild. In ornithological studies, few long-distance migrants can be tracked successfully by radio telemetry, and until recently satellite telemetry transmitters were too large for species weighing less than 500 grams due to the battery weight required to power the transmitter. This complication has been overcome with the invention of the 5 g solar-powered satellite PTT (Microwave Telemetry, Inc. - MTI). The reduction in weight from incorporating solar panels and micro-components allows researchers to utilize satellite telemetry on migratory species weighing as little as 200 grams.

The objective of this research is to obtain post breeding dispersal and wintering movements of Western Gull-billed Terns (*Gelochelidon nilotica vanrossemi*) which nest in San Diego, California. Very little information has been obtained on Gull-billed Tern wintering areas in Mexico and farther south; and even less is known of the migration routes used by these terns. Preliminary data from the PTTs highlights one of the southward migratory routes, important stop-over locations, and an important wintering location for Gull-billed Terns in Sinaloa, Mexico.

## SPATIAL ASSOCIATION AMONG ROSEATE AND COMMON TERNS, TUNAS AND CETACEANS IN THE NW ATLANTIC OCEAN

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We studied the distribution of Common (*Sterna hirundo*) and Roseate (*S. dougallii*) Terns at sea off the northeastern United States with particular attention to the possible influence of positive, facilitative interactions such as commensalism or local enhancement. These terns spend nine months of the year far offshore, yet little is known about their foraging ecology outside the breeding season. Our Bayesian hierarchical models showed that tern abundance was significantly related to sea surface temperature, depth, distance to shore, and densities of tunas and dolphins. That terns were in fact attracted to tunas was supported by the stronger association between feeding terns and tunas than that between all terns and tuna. Our analysis shows the first statistically significant spatial association among foraging Common and Roseate Terns, tunas and dolphins. We propose that these opportunistic seabirds use facilitation to locate and access prey. This study reveals patterns that infer dynamic marine processes and brings attention to the need for implementation of community-based ecosystem approaches towards marine spatial planning.

## MODELING MARBLED MURRELET HABITAT USING LIDAR-DERIVED CANOPY DATA

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LiDAR can improve characterizations of habitat relationships for wildlife species responsive to forest structure by providing fine-scale vegetation data that are inaccessible by other methods. We used LiDAR data to determine occupancy probability for the marbled murrelet (*Brachyramphus marmoratus*) in the Oregon Coast Range. Our goal was to provide a predictive tool for developing better occupancy maps and to guide habitat management. Our objective was to identify LiDAR-derived variables that can be used as reliable predictors of stand-level occupancy by murrelets. We used murrelet occupancy data collected following Pacific Seabird Group protocol, and canopy metrics calculated from discrete return airborne LiDAR data to fit a logistic regression model predicting the probability of occupancy. Our final model included distance-to-coast, and five LiDAR-derived variables (maximum of the 99<sup>th</sup> percentile of returns, maximum of the 10<sup>th</sup> percentile of returns, maximum of cover above mean canopy height, the minimum of the kurtosis of the elevation of returns, and the standard deviation of the percentage of first returns above the modal canopy height). LiDAR-derived variables provided better discrimination between occupied and unoccupied stands than variables derived from Gradient Nearest Neighbor maps that were previously reported as important predictors of murrelet occupancy. Our model can be used to identify sites that have high probability of occupancy by murrelets based on the fine-scale canopy characteristics to which this species is known to respond.

## ALCID BREEDING HABITAT RESTORATION ON SANTA BARBARA ISLAND, CALIFORNIA

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Santa Barbara Island historically hosted a large breeding Cassin's Auklet (*Ptychoramphus aleuticus*) colony, which was nearly extirpated by feral cat predation and other factors in the early 20<sup>th</sup> century. SBI is currently the largest colony location for Scripps's Murrelets (*Synthliboramphus scrippsi*) in the U.S., but colony numbers have declined since the 1970s. While all nonnative mammals have been removed from the island, impacts to native vegetation from past land use and introduced plants and animals continue to limit suitable breeding habitat. In 2007, we initiated a native plant habitat restoration project to provide additional breeding habitat for murrelets and auklets. Five acres are being restored by installing approximately 5,000 plants per year. We assessed reproductive status of murrelets and auklets annually. While no evidence of nesting auklets was found during 2007-08 surveys, small numbers of nesting birds were located during more extensive surveys in 2009-10. To facilitate auklet colonization of restored habitat, a social attraction system was deployed in January 2009. In 2010-2012, auklets responded to the social attraction system and initiated a small new colony. Auklet and murrelet reproductive success was variable in 2009-2012 and 2007-2012, respectively, with years of poor reproduction resulting from high egg depredation by endemic Deer Mice (*Peromyscus maniculatus elusus*) and adult predation by Barn Owls (*Tyto alba*). More work is needed to determine the relationships between nonnative plant cover, deer mouse, and owl abundance and to identify whether it is possible to establish viable alcid populations at current levels of predation.

## STATUS OF BREEDING SEABIRDS ON ANACAPA ISLAND, CALIFORNIA, IN 2011-2012.

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Anacapa Island is comprised of three islets totaling approximately one square mile. The lack of native large mammalian land predators allows Anacapa to host multiple species of nesting seabirds. However, numbers were significantly reduced from historic levels due to anthropogenic impacts, including marine contaminants, nonnative mammalian and plant introductions, habitat alteration and loss, and food supply limitations attributed to overfishing. In 2011, we initiated an assessment project to determine the nesting status and restoration needs of multiple species with special emphasis on the Ashy Storm-Petrel (*Oceanodroma homochroa*), which had not previously been recorded as nesting on this island, but which would be expected to benefit from restoration efforts. We used several techniques to determine whether petrels were breeding, including nocturnal mist-netting, diurnal habitat searches, and passive acoustic recording devices. Concurrently, we studied the reproductive status of seven additional seabird species, including Scripps's Murrelet (*Synthliboramphus scrippsi*), Cassin's Auklet (*Ptychoramphus aleuticus*), Pigeon Guillemot (*Cepphus columba*), Double-Crested Cormorant (*Phalacrocorax auritus*), and California Brown Pelican (*Pelecanus occidentalis californicus*). Several species have shown encouraging levels of recovery that may be attributed to the removal of the Black Rat (*Rattus rattus*); notably, we documented the first confirmed breeding of Ashy Storm-Petrels. Scripps's Murrelet showed continued signs of recovery, as did Cassin's Auklets. However, brown pelicans, which were removed from the Endangered Species List in 2009, showed a continued decline in reproductive success. This study outlines both the positive results of restoration actions as well as the need for continued monitoring and restoration of multiple seabird species.

## TEMPORAL AND ENVIRONMENTAL EFFECTS ON THE BEHAVIOR OF FLIGHTLESS CORMORANTS

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Flightless Cormorants (*Phalacrocorax harrisi*), the only flightless members of their 27-member genus, are listed as vulnerable on the International Union for Conservation of Nature (IUCN) Red List. The world population of less than 1,000 breeding pairs is restricted to scattered small colonies along the coastlines of Isla Fernandina and Isla Isabela, Galápagos, Ecuador. No previous study has systematically examined daily activity patterns by these birds in relation to environmental variables. We made half-hourly behavior scan counts at a colony of Flightless Cormorants at Cabo Douglas, Isla Fernandina during the daylight hours of seven consecutive days in May 2011. We use Generalized Linear Models and multi-model inference to examine the response of colony occupancy and behaviors to hour of day, height of tide, temperature, humidity, wind speed, barometric pressure, solar elevation, and solar flux. We show that the behavior of Flightless Cormorants is shaped primarily by time of day, wind speed, and solar flux; unlike many marine birds, they respond little to tide.

## EGG CANNIBALISM IN GULLS INCREASES WITH SEA SURFACE TEMPERATURE

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Cannibalism occurs regularly across a broad range of taxa and leads to a variety of ecological and evolutionary consequences. In communally-nesting birds, egg cannibalism can be responsible for significant decreases in hatching success. Although El Niño Southern Oscillation events and the effects of global warming have been linked to cannibalism in some animals, we are unaware of data that link alterations in climate with cannibalism in birds. While controlling for a suite of other environmental factors, we demonstrate a positive relationship between local sea surface temperature and egg cannibalism and a negative relationship between local sea surface temperature and hatching success in Glaucous-winged Gulls (*Larus glaucescens*) nesting on Protection Island, Strait of Juan de Fuca, Washington.

## SHIP MONITORING OF SEABIRDS IN THE SUBTROPICAL WATERS OF THE PACIFIC OCEAN

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Seabird distribution, abundance, and community structure surveys are routinely carried out concurrently with marine mammal and ecosystem assessment surveys by NOAA Fisheries. Three such surveys, in the subtropical waters of the Pacific Ocean and including some of the Pacific Islands (Hawaii, Palmyra and Johnston Atolls, and Kingman Reef), were conducted in 2005, 2011, and 2012. Using standard 300m strip transect methods, observers recorded seabirds continuously during all daylight hours, weather permitting. Surveys varied by time and season: 2005: 88 survey days in the Pacific Islands region between 6 August and 20 November; 2011: 28 survey days between 20 October and 17 November; 2012: 24 survey days between 23 April and 16 May. For all three cruises, the four most abundant bird groups were shearwaters, terns (including noddies), petrels, and boobies. In 2005, shearwaters were the most abundant (35.7%) followed by terns (33.0%), petrels (16.1%), and boobies (10.5%). In 2011, terns were most commonly seen (37.3%) followed by shearwaters (36.0%), petrels (12.4%), and boobies (12.1%). In 2012, shearwaters were the most abundant (33.7%) followed by terns (33.3%), boobies (22.8%), and petrels (8.0%). For all years, dominant species remained the same for shearwaters, terns, and boobies. Wedge-tailed Shearwaters made up the vast majority of shearwaters (range: 87.4% - 96%). Sooty terns dominated the tern category (range: 60.4% - 67.9%). The Red-footed Booby was the most common booby (range 72% - 88.4%). In 2005 and 2011, the Black-winged Petrel was the leading character among petrels (48.0% and 71.9% respectively); however in 2012 only one Black-winged Petrel was seen. Its conspicuous absence during the 2012 survey was likely because it had not yet returned to subtropical waters of the north Pacific from its breeding grounds in the southwest Pacific.

## SEA-SURFACE TEMPERATURE AFFECTS BREEDING DENSITY OF AN AVIAN ROCKY INTERTIDAL PREDATOR, THE BLACK OYSTERCATCHER

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Data collected in ten years (2003-2012) on Triangle Island, British Columbia, were used to test the hypothesis that the annual breeding effort of black oystercatchers (*Haematopus bachmani*) declines with increasing spring sea-surface temperature. In all ten years, between nine and 15 oystercatcher pairs laid eggs in May and June, and as predicted, the number of active nests was negatively correlated with the mean sea-surface temperature in April. However, contrary to prediction, neither mean clutch size nor mean egg size declined with temperature. Clutches composed of just a single egg, probably indicative of recruitment by inexperienced females, appeared only in the five years with sea-surface temperatures below 9° C. A reduction in the breeding propensity of individual birds, rather than increased rates of mortality or emigration, better explained why fewer oystercatcher pairs bred in warm-water years. We infer that the breeding propensity of oystercatchers is indirectly affected by sea-surface temperature, mediated by effects of temperature on the behaviour and physiology of the birds' invertebrate prey. Our results suggest a novel mechanism by which ocean warming might affect predator-prey interactions in intertidal ecosystems.

## THE AGE STRUCTURE OF BLACK-HEADED GULLS ATTRACTED TO ARTIFICIAL FEEDINGS - A COMPARISON BETWEEN DIFFERENT FOOD TYPES: ARTIFICIAL FOOD AND FISH

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Artificial feedings for Black-headed Gulls (*Larus ridibundus*) were observed in order to show the age of individuals attracted and the possible mechanisms involved. This study was conducted in Kamo River and Kowata Pond in Kyoto during the 2005-2007 winter seasons. In both study areas, a high percentage of juvenile gulls were attracted to artificial feedings of artificial foods. However, adult gulls were attracted to artificial feedings of fish. When gulls captured fish in natural conditions, foraging efficiency of young gulls were lower than that of adults. These results suggest that adults did not have to depend on the artificial feeding of low quality artificial foods such as breads because they were able to forage sufficiently for themselves. In contrast, juveniles were attracted to artificial feeding to make up for shortfalls in their daily diet. It is possible that the winter mortality of the Black-headed Gull population is suppressed due to artificial feeding in wintering areas.



## REEVALUATING THE CONSERVATION STATUS OF DE FILIPPI'S PETREL, A POORLY KNOWN CHILEAN ENDEMIC

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Gadfly petrels of the genera *Pterodroma* and *Pseudobulweria* are the second most threatened group of seabirds behind albatrosses. Despite this worrying conservation status, many *Pterodroma* species remain poorly studied and lack current population assessments. One such species, De Filippi's Petrel (*Pterodroma defilippiana*), is a Chilean endemic with a breeding distribution restricted to two island groups, the Juan Fernández and the Desventuradas islands. The species is listed as Vulnerable by BirdLife/IUCN, but empirically derived population estimates are lacking and little is known about its basic ecology. Our objectives were to reevaluate the conservation status of De Filippi's Petrel by means of population surveys and colony mapping on their breeding islands, characterization of breeding habitat and evaluation of on-colony threats. In the Juan Fernández Islands, De Filippi's Petrels breed principally on a single island, Santa Clara. The species is a breeding habitat specialist, nesting exclusively on slopes beneath and adjacent to scree and boulders. The breeding population in the Juan Fernández Islands is estimated to be approximately 477 pairs. By training and hiring a local fisherman to conduct surveys, we obtained a breeding population estimate of approximately 2300 pairs for San Ambrosio Island in the remote Desventuradas. Most populations are currently free from on-colony threats, although feral goats on San Ambrosio may disrupt breeding efforts. Our estimate of 2777 breeding pairs for the species is considerably less than the 10,000 pairs upon which its Vulnerable classification is based, suggesting that uplisting to Endangered may be warranted.

## PREVENTING ISLAND EXTINCTIONS: KNOWLEDGE PRODUCTS IN SUPPORT OF INVASIVE VERTEBRATE REMOVAL FROM ISLANDS

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Although islands make up less than 5% of the earth's land area, 80% of known species extinctions since the 1500s have taken place on islands; and 40% of IUCN Critically Endangered species currently inhabit them. Invasive Alien Vertebrates have been a primary cause of insular extinctions and are recognized as a key risk to today's threatened species. There have been over 1100 successful eradications of invasive vertebrates from islands worldwide and these represent practical and effective conservation interventions to prevent extinctions and protect biodiversity. Two key database tools to aid planning and development of these conservation actions include the Threatened Island Biodiversity database (TIB <http://tib.islandconservation.org>), and the Database of Islands and Invasive Species Eradications (DIISE <http://eradicationsdb.fos.auckland.ac.nz/>). The TIB database is the most comprehensive hub of information describing IUCN threatened species on islands at risk from invasive vertebrates, and to date has identified almost 1500 islands where 1100 endangered species are at risk from IAV. The TIB database provides key guidance by highlighting where eradications can be employed on a global scale to prevent extinctions. The DIISE records all invasive vertebrate eradications from islands worldwide, providing invasive species practitioners the opportunity to learn from global eradication experience by detailing the target species, method, and outcome from more than 1500 eradications on almost 1000 islands in 69 different countries and territories. We present demonstrations of these tools and applicability for threatened seabird islands in the Pacific.

## NOCTURNAL TRANSECT SURVEYS CAPTURE DIEL SHIFTS IN SEABIRD-HABITAT ASSOCIATIONS

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Pelagic seabird surveys are typically conducted during daytime periods, and accurate survey protocols depend on optimal visibility and environmental conditions. The spatial distribution of seabirds may differ between day and night, however, as the vertical migration of deep-water prey species at night may alter prey availability patterns at night. Documenting seabird assemblages at night can help characterize potential shifts in seabird distribution, and reveal specific habitat resources that are important at night. Using a novel nocturnal survey protocol, we compared the distribution patterns of Thick-billed Murres (*Uria lomvia*) and Black-legged Kittiwakes (*Rissa tridactyla*) between day and night in the southeastern Bering Sea. Using generalized additive mixed models, seabird densities were correlated with spatial and oceanographic habitat variables, and with acoustically derived estimates of prey abundance. The spatial distribution of murres did not differ greatly between day and night, whereas daytime kittiwake distributions shifted from the shallow continental shelf towards the 300m shelfbreak at night. Daytime kittiwake densities were significantly associated with sea surface temperature, shallow bathymetry, and juvenile pollock (*Theragra chalcogramma*) abundance, whereas deep bathymetry and proximity to the shelf break were the most significant predictive variables at night. The association of kittiwakes with the shelfbreak at night suggests nocturnal foraging on deepwater prey species such as myctophids or smoothtongue. Although seabirds can be difficult to ID during night surveys, we show that nocturnal surveys provide novel perspectives on the distribution, foraging, and provisioning patterns of many seabird species.

## TOP DOWN EFFECTS ON COMMON MURRE REPRODUCTION IN OREGON

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The breeding population of common murres (*Uria aalge*) in Oregon is approximately 685,000 birds representing 66% of the overall population within the California Current System. Murre colonies in Oregon have experienced increased levels of avian predation over the past two decades, which may be affecting population demographics. For example, at a central Oregon coast colony between 2007 and 2011 disturbances by bald eagles (*Haliaeetus leucocephalus*) caused substantial reproductive loss in some years. Additionally, there is evidence of potential regional variation in predation pressure. In 2012, we studied the reproductive success of common murres and rates of avian predation at three colonies on the north, central and south coast of Oregon. At the north coast site, murres were prevented from remaining on colony and failed during egg laying as a result of the near constant presence of eagles, with up to 11 eagles causing a single disturbance event. The central coast site experienced intermediate levels of disturbance, with a maximum of 5 eagles in a single disturbance event. This contrasted sharply with the south coast site, where only 2 eagle disturbances were observed over four months. Late season disturbance events involving north-migrating juvenile California brown pelicans (*Pelecanus occidentalis*) led to colony failure of remaining unfledged murres at the central and south coast sites in 2012. Our results indicate that top-down effects of predation vary regionally, but also that coast-wide disturbances may lead to population level effects through reduced reproductive output and failure of large breeding aggregations.

## EXPLOITING SEABIRD LOCAVORES AND THE QUEST FOR KNOWLEDGE OF NEARSHORE PREY

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Pigeon guillemots (*Cepphus columba*) and pelagic cormorants (*Phalacrocorax pelagicus*) are seabirds that nest on St. Lazaria Island, within the Alaska Maritime National Wildlife Refuge and located in the southeastern portion of the Gulf of Alaska. Both species are nearshore, central-place foragers during the summer breeding season which will allow us to study the occurrence of juvenile stages of commercially important fishes. Initial observations have shown that juvenile rockfish (*Sebastes* spp.) are consumed by pigeon guillemots at St. Lazaria. By studying guillemot diets intensively (planned) and cormorant diets (collected historically and currently), we may better understand the population patterns we have seen and may yield a better understanding of prey availability and diversity. We propose to take advantage of the seabirds' life history strategies to monitor intra- and inter-annual prevalence of juvenile fishes.

Guillemots forage within nearshore waters adjacent to the breeding colony and return to feed their young intact juvenile fish and macroinvertebrates; we plan to use high-resolution digital photography to sample diet composition without interfering with feeding activities. Diets of cormorants, which can be inferred from undigested hard parts found in regurgitated boluses, have been collected at St. Lazaria throughout the past decade. Preliminary results of cormorant diet analysis will also be presented. This information may be helpful to commercial fisheries management and monitoring the health of the Gulf of Alaska.

## SEASONAL VARIATION IN THE CROSS-SHELF DISTRIBUTION OF SEABIRDS IN THE SOUTHEASTERN BERING SEA

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We tested the hypothesis that the distribution of seabird communities across the southeastern Bering Sea shelf reflects the underlying ecology of four bathymetrically-defined hydrographic domains: the Inner Shelf (< 50 m), the Middle Shelf (50 - 100 m), the Outer Shelf (100 – 200 m), and the Shelf-Slope (200 - 3000 m) domains. We used a 35-year database and quantified the cross-shelf distribution of seabird species with respect to water depth. We then used a multivariate tree analysis to group species with similar depth-use distributions, and mapped these clusters against the hydrographic domains. There were three distinct patterns of seabird depth use: an inshore, shallow water group in spring, summer and fall, but not winter, which conformed roughly to the Inner Shelf Domain; a group of species that were distributed widely across the Middle and Outer Shelf Domains, and a third group of species that occupied the outer portion of the Outer Shelf and the Shelf-slope Domains. The multivariate tree analysis revealed close correspondence between the seabird-derived domains and the bathymetrically-defined domains in spring and, to a lesser extent, in summer. In winter (1 March -15 April), there was no inshore group and the species composition of clusters differed considerably from the other three seasons. In winter and fall, the seabird groupings failed to show a differentiation between the Inner Shelf and the Middle Shelf domains (winter), and the Outer Shelf and the Shelf-slope domains (fall). These seasonal patterns likely reflected seasonal variation in the hydrographic differentiation of the bathymetrically-defined domains.

## FORAGING AT RESTRICTED AREAS: FORAGING SITE SELECTION OF ADELIE PENGUIN

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In the Antarctic zone, the sea surface is mostly covered by thick sea ice. Therefore, the potential foraging sites for seabirds are extremely limited. To elucidate how seabirds select foraging sites in such conditions, we deployed GPS data loggers on Adélie penguins (*Pygoscelis adeliae*) and measured their foraging movements and diving behaviour at Hukuro Cove, Lutzow-Holm Bay, during the summers of 2010/2011 and 2011/2012. All dives were conducted at small ice cracks along the coast and around islands. All Adélie penguins utilized foraging sites at <1km from their colony throughout their chick-rearing period. In the late chick-rearing period, however, many Adélie penguins extended their foraging range and selected both closer foraging sites at the beginning of their foraging trips, but also used further foraging sites as far as 11km from the colony. At those further foraging sites, penguins showed high foraging site fidelity. Penguins could not travel by swimming around Hukuro Cove, because almost 100% of the sea surface was covered with fast sea ice. Walking speed of penguins is only 1/4 of their swimming speed, and walking requires higher energy expenditure. To minimize their energetic and time costs, all Adélie penguins tend to utilize closer foraging sites throughout their chick-rearing period. Due to the high concentration of penguins foraging at the extremely limited closer foraging sites, prey depletion may occur. We believe that Adélie penguins extended their foraging range and showed high foraging site fidelity as a response to the prey depletion around their colony in the late chick-rearing period.

## BROWN PELICAN MORTALITY PATTERNS IN THE U.S. PACIFIC NORTHWEST

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We used a combination of rehabilitation intakes, necropsies, and field surveys at communal roosts to investigate brown pelican (*Pelecanus occidentalis californicus*) mortality patterns near the northern limit of the U.S. Pacific coast non-breeding range, between about 45°-47° N. Data from 2008-2012 indicated that most injury occurred in late fall and winter while greatest seasonal pelican abundance occurred in summer. The most common cause of mortality was physical injury sustained from diving and heavy surf (53%), followed by starvation (28%). About 6% of all injuries in the sample of nearly 200 birds were directly attributed to anthropogenic sources such as fishing line entanglement and plumage contamination. Mortality patterns varied by age class, season, and year. Adult body condition typically declined in winter, coincident with onset of storms, southern migration, increased occurrence of scavenging in harbors, and unusual food items in stomach contents. Juveniles were the predominant component of summertime mortality during 2011-2012, when many hatch-year birds that migrated north apparently arrived emaciated. Spikes in mortality occurred during 2008-2010, in association with anomalous winter attendance by pelicans in Oregon. Field monitoring, attention to specific environmental variables, and range-wide communication between pelican researchers and rehabilitators can help predict pelican vulnerability to injury in the migratory corridor. Secondary anthropogenic harm to these coastal seabirds can be prevented by public education and proper management of fish waste in harbors.

## USING AT-SEA DISTRIBUTION OF SEABIRDS TO SELECT THE AREA FOR THE PROPOSED SCOTT ISLANDS NATIONAL WILDLIFE AREA

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The Scott Islands include five islands off the northern-western tip of Vancouver Island, British Columbia (BC). Three of these islands support approximately 1.4 million nesting seabirds, representing about 40% of the seabirds breeding along Canada's Pacific coast. While the Islands are protected by the BC government, the adjacent waters are unprotected. The Canadian Government committed to having the Scott Islands National Wildlife Area (NWA) ready for designation in 2012. Selection of area for the proposed NWA was based on conservation priorities, social-economic objectives, and other marine planning processes. Consultations with government agencies, First Nations and stakeholders were extensive throughout the planning process. The criteria used to design the proposed NWA included documented use of marine areas by the majority of the federally-managed seabird species nesting on the Islands, with a priority for areas used by the species for which the Islands have the highest stewardship responsibility (in terms of the proportion of regional, national or global populations). Additionally, a distance of approximately 65 km from Triangle Island (the most important of the Scott Islands in terms of diversity and numbers of breeding seabirds) was used as a guideline for the boundary. Sixty-five km represents the average one-way foraging distance of Cassin's Auklets (*Ptychoramphus aleuticus*) and Rhinoceros Auklets (*Cerorhinca monocerata*) from Triangle Island. The proposed NWA covers approximately 11,546 km<sup>2</sup>, or roughly 2.5% of Canada's Pacific Exclusive Economic Zone. The proposed NWA adds to the growing global trend of using information on seabirds to help plan marine protected areas.

## MODEL-BASED ABUNDANCE ESTIMATES OF THE HAWAIIAN PETREL (*PTERODROMA SANDWICHENSIS*) AND NEWELL'S SHEARWATER (*PUFFINUS NEWELLI*) BASED ON DATA COLLECTED AT SEA, 1999-2011

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The absence of abundance estimates for the Endangered Species Act listed Hawaiian Petrel (*Pterodroma sandwichensis*) and Newell's Shearwater (*Puffinus newelli*) since 1995 currently impedes conservation decision-making and resource allocation for these species. This analysis provides oceanic abundance estimates for these species within surveyed areas of the central and eastern tropical Pacific using 300m strip-transect data collected aboard National Marine Fisheries Service ecosystem assessment cruises over the period 1999-2011. To identify underlying abundance patterns from stochastic seabird count data, a stepwise Generalized Additive Modeling process was employed using latitude, longitude, distance-to-colony, and day-of-year as covariates. This method allowed for non-linear relationships, and a non-random distribution of survey effort. Over the sampling period 350 observations of 415 Hawaiian Petrels, and 155 observations of 282 Newell's Shearwaters were made in 59446.7 km<sup>2</sup> of surveyed transect area. The model selected for the Hawaiian Petrel based on Akaike's Information Criterion score contained cubic regression spline smooth functions of latitude, longitude, and day-of-year, each with 4 degrees of freedom, and explained 32.2% of the deviance in counts. Similarly, the most parsimonious model for the Newell's Shearwater contained latitude, distance-to-colony, and day-of-year, with up to 6 degrees of freedom in each smooth function, and explained 47.1% of the deviance in counts. These models will be used to predict counts over a 1° grid. This survey effort included areas not sampled in the previous efforts, but failed to encompass the entire range of either species, thus these abundance estimates represent subsets of the total marine populations of each species.



## SEABIRD INFORMATION NETWORK: A PARTNERSHIP TO ARCHIVE AND VISUALIZE NORTH PACIFIC SEABIRD DATA

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Seabirds.net provides public access to the Seabird Information Network (SIN). One of three seabird data portals linked to SIN is the North Pacific Seabird Data Portal (NPSDP), an on-line web portal with two databases (North Pacific Seabird Colony Register, North Pacific Seabird Diet Database) and two indices (North Pacific Seabird Population Trend Index and the North Pacific Seabird Productivity Index). These databases and indices use a Google Maps® interface to display information to the public (front-end). Upon request, a user name and password is assigned to a data contributor and permits access to the on-line data entry application (back-end). Contributors may use the databases to archive their data, choosing one of three data release codes (unrestricted, restricted, and provisional) to determine how data would be disseminated during data download requests. The indices allow seabird researchers to quickly share preliminary results on population trends (over a 10-year period) and seabird productivity (relative to long-term average at the colony) and uses a red circle (declining population trend/poor productivity), amber circle (stable population trend/moderate productivity), or green circle (increasing population trend/good productivity) at a colony location. The North Pacific Seabird Data Portal provides the tools needed by today's seabird researchers to archive both legacy and contemporary seabird data while also sharing information with other scientists and the general public.

## MERCURY CONCENTRATIONS IN TISSUES OF FOUR AVIAN SPECIES AT AGATTU ISLAND, ALEUTIAN ARCHIPELAGO, ALASKA

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Mercury (Hg) is a toxic element that is transported atmospherically, distributed globally, and can negatively influence avian populations. Agattu Island, located in the western Aleutian Archipelago, Alaska, is a remote island that does not have a history of anthropogenic Hg contamination. Using samples collected at Agattu Island from 2005-2006 and 2008-2011, we analyzed total mercury (THg) concentrations of feathers and eggshells of four bird species. Total Hg concentrations were relatively consistent between years for all species. Breast feathers of Fork-tailed Storm-petrels (*Oceanodroma furcata*) had the highest THg concentrations. Total Hg concentrations of egg shells and body feathers of adult and nestling Kittlitz's Murrelets (*Brachyramphus brevirostris*) were relatively high compared to similar species and were comparable to concentrations in feathers of Snowy Owls (*Bubo scandiacus*), a top marine avian predator in the Aleutian Islands. As predicted by feeding guild, Evermann's Rock Ptarmigan (*Lagopus muta evermanni*) feathers had the lowest THg concentrations. Overall, avian tissues analyzed from Agattu had greater THg concentrations than would be expected for a remote location with no point-source Hg pollution.

## CHANGES IN NEST AND INCUBATION TEMPERATURE OF CASSIN'S AUKLETS IN ARTIFICIAL NEST BOXES, SOUTHEAST FARALLON ISLAND

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The use of artificial nest boxes is a common tool for increasing nesting habitat and monitoring the breeding behavior of burrowing seabirds, like Cassin's Auklets (*Ptychoramphus aleuticus*, hereafter auklet). However nest box design with regard to chamber temperature and its effect on incubation has not been well studied. Researchers from PRBO Conservation Science have discovered that auklets nesting in unshaded artificial nest boxes on the Southeast Farallon Island (SEFI) experience heat stress on days with high ambient temperatures. Shade structures have since been added to nest boxes to help ameliorate the elevated temperatures. Using temperature loggers placed inside the nest box chamber and nest cup, we examined whether the incubation temperatures of nesting auklets varied between shaded and unshaded nest boxes on SEFI during the 2012 season, using auklets in natural burrows as controls. Overall, we found higher incubation temperatures in unshaded ( $37.7 \pm 1.6^\circ\text{C}$ ,  $n=15$ ) and shaded ( $37.6 \pm 1.3^\circ\text{C}$ ,  $n=14$ ) nest boxes compared to natural burrows ( $35.8 \pm 1.7^\circ\text{C}$ ,  $n=6$ ), and that the net difference between chamber and cup temperature was higher in shaded ( $22.1 \pm 1.0^\circ\text{C}$ ,  $n=14$ ) and unshaded ( $22.4 \pm 4.6^\circ\text{C}$ ,  $n=15$ ) nest boxes compared to natural burrows ( $20.5 \pm 1.4^\circ\text{C}$ ,  $n=6$ ). There was a significant relationship between chamber temperature and cup temperature, where cup temperature increased concomitantly with chamber temperature. These results suggest that incubation temperatures are warmer in artificial burrows, but auklets may be able to mitigate higher temperatures in artificial boxes for incubation. However, further studies are needed to investigate whether higher incubation temperatures in artificial nest boxes impact incubation behavior or breeding performance.

## DIET OF A TOP MARINE AVIAN PREDATOR FROM THE WESTERN ALEUTIAN ARCHIPELAGO, ALASKA

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The Snowy Owl (*Bubo scandiacus*) is a circumpolar species with a diet composed mostly of small mammals. At Agattu Island, an island lacking terrestrial mammals, in the Aleutian Archipelago, Alaska, Snowy Owls subsist entirely on a diet of birds. We analyzed the contents of 104 Snowy Owl pellets collected at Agattu Island during May-August 2008. We document the importance of seabirds in the diet of Snowy Owls at Agattu Island, which is home to over 40,000 breeding seabirds. Storm-petrels (*Oceanodroma* spp.) were the most frequent prey item (61%), and contributed 18% of overall biomass. Ancient Murrelets (*Synthliboramphus antiquus*) were found in 20% of pellets and accounted for 23% of the overall biomass. Large prey such as the Aleutian Cackling Goose (*Branta hutchinsii leucopareia*) and Mallard (*Anas platyrhynchos*) were infrequent in pellet remains (1% and 2%, respectively), but contributed substantially to overall biomass (7% and 13%, respectively). Snowy Owl observations were rare, but an adult was observed on six separate occasions during June-August and on one occasion, two individuals were seen together. In addition to pellet diet analysis, we documented a Snowy Owl depredation of a Kittlitz's Murrelet (*Brachyramphus brevirostris*) chick at the nest. We suggest that Snowy Owls in the western Aleutians are a top marine predator and consume a significant proportion of nocturnally active seabirds at their breeding colonies.

## HOW DO THEY FLY AND SWIM? DYNAMIC SIMILARITY BETWEEN FLIGHT AND SWIMMING IN RHINOCEROS AUKLETS

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Alcids are remarkable seabirds, they employ wing propelled flight and swimming, in spite of different demands. For example, long span wings are efficient for flight, though short span wings are efficient for swimming, because of the drastic difference of air and sea water density. Our question is : How do alcids produce thrust efficiently in air and sea? Strouhal number(St) should be the key to help this answer. St is a dimensionless number and the indicator of propulsive efficiency, usually peaks within the interval  $0.2 < St < 0.4$ . In many flying or swimming animals are known to tune as efficient value( $0.2 < St < 0.4$ ) during cruising. St is defined as  $St = \text{wingbeat Frequency} * \text{wing stroke amplitude} / \text{forward speed}$ . Thus, we hypothesize that alcids might adjust the wing kinematics and tune St as 0.2 - 0.4 during flight and swimming. To test the hypothesis we measured wingbeat frequency, wing stroke amplitude and forward speed using micro data loggers and video movies on Rhinoceros auklets *Cerorhinca monocerata* at Teuri Island, Japan. Rhinoceros auklets fly at  $15.66 \pm 0.9 \text{ m/sec}$  and flap at high frequency( $8.81 \pm 0.3 \text{ Hz}$ ) with large amplitude( $0.32 \text{ m}$ ). In contrast, they swim at  $1.28 \pm 0.1 \text{ m/sec}$  and flap at low frequency( $2.61 \pm 0.4 \text{ Hz}$ ) with small amplitude( $0.14 \text{ m}$ ). St is calculated as 0.18 during flight and 0.27 during swim. Therefore, Rhinoceros auklets change their wing movement and tune the St as efficient value during flight and swimming.

## PREDICTIVE MODELS OF MARINE BIRD DISTRIBUTION AS A SPATIAL PLANNING TOOL: A CASE STUDY IN THE U.S. MID-ATLANTIC

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Marine birds are highly mobile organisms that range widely and respond to dynamic features in their physical and biological environment at time scales from minutes to decades. Marine spatial planning can help minimize risks to marine birds from new offshore ocean uses such as renewable energy facilities, but requires high-quality spatial information. Maps are needed that characterize the persistent spatial features of at-sea marine bird occurrence probability and relative abundance, as well as uncertainties arising from incomplete sampling and inherent variability. Yet, moving from scattered, heterogeneous at-sea survey transect data to gap-free, high-resolution distribution maps at the relatively fine spatial scales (~1km horizontal resolution or better) often needed for marine spatial planning is a formidable statistical challenge. We present a case-study from the U.S. Mid-Atlantic in which we combine >30 years of at-sea survey data from 32 datasets with a large database of high-resolution oceanographic and environmental predictor variables to predict marine bird occurrence and abundance. An ensemble machine-learning technique known as component-wise boosting was adapted to account for complex interactions and non-linearities, spatial correlation, temporal effects and zero-inflation. We use this model to develop predictions of individual species and functional group occurrence and abundance, as well as community metrics such as species richness and diversity. We show how model outputs can be tailored to maximize their use to planners, decision-makers, and stakeholders in marine spatial planning processes. Finally, we give real-world examples of how modeling products have been used, and are anticipated to be used, to reduce conflicts between marine bird habitat and ocean energy facilities in the U.S. Atlantic.

## BETWEEN-POPULATION VARIABILITY IN BODY SIZE AND ACOUSTIC COMMUNICATION OF WHISKERED AUKLET (*AETHIA PYGMAEA*).

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The whiskered auklet breeds on a few remote islands of Bering and Okhotsk Seas and displays complex social behavior, possesses bright plumage ornamentation and developed acoustic communication. The difference in body size have been reported for Kurilian and Aleutian birds, however until recently colonies from Sea of Okhotsk remained unexplored as well as population variations in vocal characteristics of the species. We collected data at Buldir I., Aleutians (June-July 1993), at Saint-Jonah (Iona) I., Sea of Okhotsk (July 2009) and at Medny I., the Commander Islands (June-July 2012). We measured body weight and wing, tarsus, bill, crest lengths. Ten temporal-frequency parameters of Mew and Beedoo calls were analyzed, as well. We found that Saint-Jonah birds were significantly larger than Buldirian ones (T-test,  $p < 0.001$  for all comparisons). We didn't find any overlap in weight and tarsus length between populations (e.g. weight(g): Saint-Jonah:  $146.5 \pm 8.4$ ,  $n=15$ ; Buldir:  $110.1 \pm 6.1$ ,  $n=64$ ). Saint-Jonah auklets also emitted lower in fundamental frequency calls than Buldirian ones (ANOVA,  $p < 0.001$  for all comparisons). The Medny I. birds occupy intermediate position (e.g. wing length (mm): Saint-Jonah:  $113.2 \pm 3.6$ ,  $n=15$ , Medny:  $111.7 \pm 3.1$ ,  $n=29$ , Buldir:  $106.8 \pm 3.1$ ,  $n=114$ ; peak fundamental frequency of Mew call (Hz): Saint-Jonah:  $973 \pm 84$ ,  $n=100$ , Medny:  $1078 \pm 92$ ,  $n=100$ , Buldir:  $1109 \pm 114$ ,  $n=100$ ). Also studied populations reveal different rhythms of activity at the colony surface: while Medny and Buldir I. birds are nocturnal, the Saint-Jonah auklets are completely diurnal. Our data proved the strong inter-population variability in this species. However additional studies, especially genetic, are necessary for better understanding the species' population structure and ecology.

## CLIMATE CHANGE IMPACTS ON THE BLACK OYSTERCATCHER AND POTENTIAL SUSTAINABLE MANAGEMENT SOLUTIONS

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The Black Oystercatcher (*Haematopus bachmani*) is a shorebird species of high conservation concern. Climate change impacts on marine shorelines are expected to further tax this species by reducing intertidal habitat and reducing larval recruitment of Black Oystercatcher prey species. Tectonic plate movement complicates predictions concerning sea level rise and habitat loss throughout the range of the Black Oystercatcher. Threats to the Black Oystercatcher are articulated and sustainable management options are explored.

## CAN CHAINSAWS BE A GOOD SOUND FOR MARBLED MURRELETS?

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In Southwest Washington less than one percent of old-growth forest remains, making this portion of the coast a potentially vulnerable gap in the marbled murrelet (*Brachyramphus marmoratus*) population. The marbled murrelet is critically dependent on this small remaining amount of old forest nesting habitat. However, the vast majority of the forested landscape here is harvested for timber and wood fiber production on clear-cut cycles of 35 to 50 years. These young, even-aged industrial forests often do not provide forest structure needed for murrelet nesting. With so little nesting habitat remaining, recovery of murrelet populations will require learning how to restore complexity within these even-aged forests; a long term prospect for which there is no guidebook. Can development of old forest conditions be accelerated through restoration actions in coastal forests and are these treatments economically feasible?

The Nature Conservancy (TNC) owns and manages the 8000 acre Ellsworth Creek Preserve in Southwest Washington near Willapa Bay. To understand how restoration might improve forest conditions and watershed function for a variety of species, including marbled murrelets, TNC has established a long-term experimental design in eight sub-basins within the Ellsworth Preserve. We use variable density thinning prescriptions that enhance development of forest complexity while avoiding conflicts with resident marbled murrelets. The experimental design tests the difference in outcomes from an active vs. passive approach to forest restoration. The goal of this work is to restore Ellsworth Creek forests and to serve as an example for other conservation minded land owners interested in forest restoration.

## INDIVIDUAL SPECIALIZATION IN THE DIVING BEHAVIOUR OF A WIDESPREAD NORTH PACIFIC MARINE PREDATOR

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Foraging behaviour in many seabird species is specialized. This species-specific specialization is mainly due to morphological constraints but also controls interspecific competition for prey. But competition for food resources can also occur between individuals of the same species when foraging habitat and/or prey resources are limited. This is especially true during the breeding season when seabirds are central-place foragers and have to search for food in a limited area around their colonies. Therefore, individual specialization is widespread in seabirds. This individual specialization is often gender or age related and is potentially high in diving seabird species.

In this study we examined the foraging behaviour of Pelagic Cormorants (*Phalacrocorax pelagicus*) at Middleton Island in the Gulf of Alaska over three successive years, with special emphasis on individual birds that were tagged during two or three consecutive years, respectively. All cormorants showed high foraging site fidelity over all study years. The reliance on that restricted foraging site seems to develop individual-specific diving behaviour. Nearly half (46%) of the individually observed birds did not differ in their diving behaviour or foraging trip parameters between the study years, indicating an individual specialization of their foraging behaviour not only during one season but also in consecutive years. Such specialization might be a strategy to avoid intraspecific competition when relying on a narrow foraging area. Thus, individual specialization might be advantageous for the breeding effort but the inability to move to or use other foraging areas could also be critical in case of changing environmental conditions.



## IDENTIFYING IMPORTANT PELAGIC AREAS IN THE PACIFIC ARCTIC: SEASONAL AND SPATIAL PATTERNS IN MARINE BIRD AND MAMMAL DISTRIBUTION

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The prospect of rapid climate change and increased human activity in the Pacific Arctic requires improved understanding of marine bird distribution and relationships among oceanographic conditions, lower trophic species, and higher trophic species. Our goal, as part of the multidisciplinary Synthesis of Arctic Research, is to describe the broad scale seasonal patterns in pelagic distribution of marine birds and mammals in the North Bering Sea, Chukchi Sea and Alaskan Beaufort Sea. We integrated data from 2006-2012, including line transect aerial surveys for marine mammals (~139,000 km surveyed) and strip transect shipboard surveys for seabirds (~30,000 km surveyed). Survey data were standardized to 40 km grid cells over the study area and we used Getis-Ord Gi\* Hotspot Analysis to examine patterns in bird abundance. Bird and mammal seasonal patterns in the Arctic are strongly influenced by the extent of sea ice coverage, the brief season of open water, and the late-summer influx of southern migrants, therefore we quantitatively examine spatial community structure in spring (March-May), summer (June-August) and fall (September-November). In early spring, with the exception of eiders aggregated south of St. Lawrence Island, marine bird densities and species richness were low and restricted to open leads. Marine bird densities increased by an order of magnitude from April through September and dropped dramatically in October; species richness also peaked in September. For each season, we identify areas with high species diversity and high relative abundance, which can be used to focus future efforts to describe mechanisms affecting upper trophic levels.

## THE MURRELET IN WINTER – A REVIEW OF MARBLED MURRELET POST-BREEDING DISTRIBUTION WITH A FOCUS ON ALASKA

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During the breeding season Marbled Murrelets (*Brachyramphus marmoratus*) are found in coastal waters from Alaska to California, but little is known about their distribution from fall through winter. Post-breeding molt and dispersal of murrelets from central California were inferred from mark-recapture and at-sea surveys (Peery et al. 2008) and genetic analysis (Hall et al. 2009). These studies suggested variable temporal and geographic patterns of post-breeding distribution. At the northern end of their range, we used ship-board surveys in Alaska to examine seasonal distribution of murrelets. In offshore waters (2006-2012, >158,000 km surveyed) few murrelets occurred there during summer, but by August they appeared in the northern Gulf of Alaska (GOA) shelf and southeast Bering Sea. During fall, highest densities were encountered in the inner shelf, across outer Bristol Bay, where prey appeared to be abundant. A few individuals were recorded in the outer and middle shelf and as far north as the Bering Strait. In winter/spring, individuals occurred on the outer shelf to ~60°N and near the Aleutian Islands, but most sightings were in the northern GOA coastal waters from Kodiak to Prince William Sound (PWS). Surveys in PWS (1989-2012) show that murrelets ‘overwinter’ there regularly, but the March population varied from 10 to 60 percent of population estimates the following July; conditions in the GOA may account for this variability. The pattern is complicated, however, as murrelets leave PWS throughout August prior to post-breeding molt, reappear by November, peak in January, and decline slightly by March.

## RESTORING COMMON TERN NESTING HABITAT USING BURNING AND WEED BARRIERS

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As seabird nesting colonies have become concentrated on fewer managed islands in the Gulf of Maine, available nesting habitat for open-ground nesters such as the Common tern (*Sterna hirundo*) has rapidly become overgrown by guano-fertilized vegetation, leading managers to try various methods of vegetation control to open usable nesting habitat. However, little scientific research has been conducted to address vegetation management in the context of seabird nesting habitat. We experimentally tested two of these methods, burning and synthetic weed barrier treatments, to assess their ability to open and maintain Common tern nesting habitat on two near-shore seabird nesting islands in Maine in 2009 and 2010. After applying treatments to overgrown habitat pre-nesting, we monitored vegetation regrowth and tern nest and fledging success in treated plots, vegetated control plots, and pre-existing tern nesting habitat. We found that burned areas did not remain open for the full nesting season, but regrew shortly after egg-laying, leading to near-complete nest failure in these plots. However, vegetation characteristics produced by the two different weed barrier treatments – one a layer of muslin fabric overlaying newspaper mulch, and the other a mosaic of synthetic turf and open ground—were similar to vegetation in pre-existing tern nesting habitat throughout the season. Tern nest and fledge success was similar in weed barrier plots (1.37 chicks/pair) and pre-existing tern nesting habitat (1.38 chicks/pair). While burning may not be a useful technique for creating nesting habitat, synthetic weed barriers offer a promising short-term solution to vegetation overgrowth in tern colonies.

## HOW THE BREEDING ECOLOGY OF KITTLITZ'S MURRELET MAKES SENSE (SOMETIMES): THE BENEFITS OF HIGH-QUALITY FORAGE AND RAPID CHICK GROWTH ON NEST SURVIVAL AND ADULT FITNESS.

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Kittlitz's murrelet (*Brachyramphus brevirostris*) is a semi-precocial alcid that is unusual among seabirds because it nests non-colonially in alpine areas that are often located far from the sea. Our sample of 53 active Kittlitz's murrelet nests found on Kodiak Island, Alaska suggests the adaptive significance and potential limitations of its breeding strategy. Fresh egg mass was disproportionately large compared with confamilials, and the chick-brooding period was very short, suggesting precocial development of chick thermoregulation. Parents almost exclusively delivered Pacific sand lance (*Ammodytes hexapterus*), a high-lipid schooling forage fish, to chicks. Parents made an average of 4.34 meal deliveries/day, similar to most other fish-provisioning semi-precocial alcids. However, parents made an average of only 107 total provisioning visits to the nest before chick fledging, far lower than all fish-provisioning semi-precocial alcids except the congeneric marbled murrelet. Chick growth was faster and the nestling period was shorter than for any other semi-precocial alcid. Nest success rates were low (0.093), and nest depredation was the major constraint on productivity. The breeding ecology of Kittlitz's murrelet suggests a trade-off

between access to rich food resources and inherently high-risk nest sites. The availability of high-quality forage fish allows for a short nestling period that minimizes time-dependent nest mortality, while reducing energetic demands on adults. Changes in the availability of high-quality forage fish would be expected to affect the reproductive success of Kittlitz's murrelets to a much greater degree than seabirds with a more typical breeding strategy.

## REPRODUCTIVE SUCCESS OF LAYSAN AND BLACK-FOOTED ALBATROSS AT MIDWAY ATOLL NATIONAL WILDLIFE REFUGE OVER ELEVEN SEASONS

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Midway Atoll National Wildlife Refuge (NWR) is home to the largest nesting colonies of Laysan (*Phoebastria immutabilis*) and Black-footed albatross (*Phoebastria nigripes*) in the world. These long-lived species take years to reach sexual maturity and have a low reproductive rate. Laysan and Black-footed albatross are an important indicator species for the U.S. Fish and Wildlife Service for monitoring the health of the North Pacific Ecosystem. The hatching, fledging, and reproductive success rates of the albatross were monitored at Midway Atoll NWR from 2002 through 2012. Despite differences in foraging areas and diet between the two species, rates for hatching, fledging, and reproductive success over the eleven year period were 81%, 83%, and 67% respectively for both species and are not statistically different. Single season differences were statistically significant between the three measures, but it seems that the factors influencing the reproductive success of these two species in one nesting colony are very closely related despite species differences.

## TEMPORAL CHANGES IN LIPID PLASMA METABOLITES DURING THE BREEDING SEASON OF BLUE-FOOTED BOOBIES

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Seabirds exhibit changes in their body condition during the breeding season due to energetic costs and associated stress. It is possible that these costs can differ between sexes, particularly when there are sex-related differences in body size. We evaluated changes in body condition during the breeding season of Blue-footed boobies (*Sula nebouxi*; females are 31% heavier than males) using triglyceride and B-OH-butyrate levels. We collected 219 blood serum samples of adults from incubation (2011) or courtship (2012) to rearing of fledglings in El Rancho Island, Sinaloa, Mexico. In both years, triglyceride levels increased from incubation to rearing of fledglings, and males had higher B-OH-butyrate levels than females. In 2012, females had higher levels of triglycerides than males particularly during courtship, B-OH-butyrate levels were lower during courtship than in the next stages, and brood size were associated with metabolite levels during incubation (larger clutch, higher B-OH-butyrate levels) and chick rearing (larger brood, higher triglyceride levels). It appears that parents reach their lowest body condition during incubation and then begin a process of recovery. Higher triglyceride levels found in females during courtship could be related to egg formation and laying demands. The B-OH-butyrate differences between sexes suggest that males use their body reserves more than females throughout the breeding season. Interannual variation in body condition of parents indicates that parents do not normally work at maximum energy expenditure while breeding (2011), but probably under harder environmental conditions, variations in body condition of parents related to clutch and brood size arise (2012).

## ASSESSING RAPTOR PREDATION ON KITTLITZ'S MURRELET IN A RECENTLY-DEGLACIATED COASTAL FJORD

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The Kittlitz's Murrelet (*Brachyramphus brevirostris*) is a solitary-nesting seabird that, during the breeding season, is most abundant in tidewater glacier fjords. This is a dynamic habitat that is changing rapidly as glacial recession creates new habitats usable by other species (e.g., raptors). With newly-provided nesting substrate and habitat to support alternate prey species, these aerial predators may impact species, like Kittlitz's Murrelet, that rely on this glacial habitat. During a study of the Kittlitz's Murrelet in Icy Bay, Alaska, predation of murrelets by Bald Eagles (*Haliaeetus leucocephalus*) and Peregrine Falcons (*Falco peregrinus*) during the breeding season exceeded murrelet reproduction. We monitored raptor nests with still-cameras and collected prey remains at nests and plucking posts to describe the raptor diet. Falcons consistently preyed on murrelets, which were found in the diet at ~80% of the eyries. In contrast, murrelets were only occasionally delivered to eagle nests. Falcons were the most common predator of Kittlitz's Murrelets and this predation likely occurred near the water, not at the nest. Predation pressure and confirmed events by falcons in areas with recent deglaciation is likely a contributing factor to the apparent decline of the Kittlitz's Murrelet.

## USING SEABIRDS AS SENTINELS OF ECOSYSTEM HEALTH OF THE SOUTHERN CALIFORNIA BIGHT: DEVELOPING A COLLABORATIVE ASSESSMENT OF SEABIRDS AND COASTAL ENVIRONMENT CONDITION

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The need to measure and evaluate ecosystem health is urgent. The use of indicator species as a proxy for ecosystem health is a powerful and efficient way to measure changes in environmental condition. Seabirds have been shown to serve as effective indicators of marine health and can detect changes in ecosystem quality in relevant timescales. Contaminants are found in high quantities in seabirds due to bioaccumulation, and biomagnification. Seabirds also exhibit sub-lethal, physiological effects from contaminant exposure, such as eggshell thinning. 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, Southern California Coastal Water Research Project (SCCWRP) has conducted a Southern California Bight-wide monitoring program to improve the efficacy of existing monitoring programs, and improve capacity for regional assessments. The Bight program has traditionally included sediment, water, invertebrate, fish, and habitat components in its program. In 2013, seabirds will, for the first time, be included in this assessment to determine exposure levels across the region and consider bioaccumulation along trophic pathways. Here we describe the Bight program seabird monitoring program design, how it builds on existing data collection and the questions this monitoring program will answer. By targeting seabirds across feeding guilds that are spatially distributed throughout the Bight, and integrating seabird data within the context of the Bight monitoring program, this regional monitoring project will establish site specific condition as well as assessments that can inform large-scale management and policy.

## USE OF AERIAL IMAGERY AND GIS TO ESTIMATE COLONY SIZE AND AREA OF GROUND-NESTING SEABIRDS: BETTER TOOLS FOR MONITORING SEABIRD POPULATIONS

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The ability to accurately estimate seabird colony size using repeatable methods is important for detecting trends in colony sizes and overall population size. For large or difficult to access colonies, it is often not feasible to accurately estimate colony size from observation blinds or other vantages. To address this problem, we developed methods of estimating ground-nesting seabird colony size from high-resolution aerial photography using GIS tools. Our approach is effective for counting a variety of species that nest in the open and are distinguishable on aerial images, including most species in the following taxa: Sphenisciformes, Diomedidae, Pelecanidae, Phalacrocoracidae, Sulidae, Larinae, Sterninae, and murre (Uria spp.). We hired a professional photographic service to collect vertical aerial imagery of seabird colonies using large format digital or forward motion compensating film cameras (film images were later scanned at 12-μm resolution). Digital images in a TIFF file format were georeferenced and resampled to a  $\leq 2$ -cm pixel size and stitched into a single SID image. A custom colony-counting application was developed in ArcGIS to mark individual birds or nests on aerial imagery. Where estimates of variability in photo interpretation were desired, counts of birds or nests were produced by three observers working independently. In 2011 and 2012, processed aerial imagery was served to counters via an online application developed using the ArcGIS API for Silverlight. Bird or nest locations and colony boundaries digitized in the counting application were archived in a SQL Server database for potential future analysis.

## ANNUAL SURVIVAL OF AN ARCTIC-WINTERING SEABIRD IN THE 21<sup>ST</sup> CENTURY: ARE RECENT DECREASES IN SUMMER ICE AFFECTING OVERWINTER SURVIVAL

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Loss of summer sea ice in the Arctic has been unprecedented in the last decade with the record 2012 sea ice minima of 3.4 million sq. km half of the 1979-2000 average. There are few time series available for examining the biological effects of this ice loss on species dependent on the cryopelagic marine ecosystem associated with sea ice. A Black Guillemot (*Cephus grylle*) colony on Cooper Island, Alaska studied annually since 1975 has experienced decreases in breeding success in the last decade as increasing summer ice retreat and rising sea surface temperatures now regularly limit availability of Arctic Cod (*Boreogadus saida*), the preferred prey of parents provisioning nestlings. Ice conditions have also changed during the guillemots' nonbreeding season with post-breeding birds now traveling many hundreds of kilometers north to find their preferred sea ice habitat, freeze-up occurring later in the fall and winter ice habitats having decreasing amounts of thick multi-year ice. To determine if changes in the nonbreeding ice habitats are affecting overwinter survival we examined apparent annual survival for the years 2000 to 2012 for 709 breeding birds. The potential effects of annual variation in ice location, extent and type were examined. Our analysis provides important information on an upper trophic level pack-ice obligate during a time of rapid change in arctic pack ice and before the predicted complete disappearance of summer ice in coming decades.



## MARBLED MURRELET RECOVERY IMPLEMENTATION TEAM MEETING AND STAKEHOLDER WORKSHOP REPORT

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The U.S. Fish and Wildlife Service (Service) convened the Marbled Murrelet (*Brachyramphus marmoratus*) Recovery Implementation Team (RIT) and held a Stakeholder Workshop in October 2011. The objectives were to: evaluate the specific causes of the continued decline throughout the murrelet's listed range in Washington, Oregon, and California; determine the relative importance of threats/causes of the decline; and develop a prioritized list of implementable actions to be taken in the short-term to stem the population decline (next 5-10 years). The RIT determined that the primary source of the continued population decline is sustained low recruitment caused by historic and ongoing loss of terrestrial habitat, nest predation, changes in marine forage, post-fledging mortality, and cumulative and interactive effects. The causes were prioritized by geographic areas. Actions that might be taken to address low recruitment were identified and ranked by geographic areas. The highest ranked actions included: development of a landscape-scale strategy and incentive programs to protect nesting habitat; improving and increasing outreach; revising critical habitat to include marine habitat and establishing marine protection areas; supporting forage fish surveys, research, and strengthening laws; designing renewable energy structures to minimize impacts; incorporating murrelet impacts in new campground/day use area designs; and improving and increasing trash management. The report is available at <http://www.fws.gov/wafwo/pdf/FinalReporMarbledMurrelerRITandStakeholderWorkshop.pdf>.

## CRUISE SHIP DISTURBANCE TO KITTLITZ'S MURRELETS IN GLACIER BAY NATIONAL PARK, ALASKA

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Due to recent population declines, the Kittlitz's Murrelet (*Brachyramphus brevirostris*) is being considered for listing under the Endangered Species Act. In advance of this decision, we conducted a two-year study into the response of Kittlitz's Murrelets to cruise ships traveling within Glacier Bay National Park. Glacier Bay supports an estimated 10-15% of the world's population of Kittlitz's Murrelets during the breeding season and cruise ships serve as an important means by which more than 95% of visitors access the park. Observers conducted observations from the bow of cruise ships (22 cruises in 2011, 24 in 2012) to record responses of both Kittlitz's Murrelets ( $n = 1,251$ ) and Marbled Murrelets (*B. marmoratus*,  $n = 1,274$ ) to approaching ships. More than 60% of all focally-followed birds ultimately flushed (flight; versus diving or no reaction) as ships approached although there was large variation in responses, with some flushing 900 m in advance while others let the ship pass within 90 m without flushing. Marbled Murrelets flushed at a greater median distance from the ship (338 m vs. 258 m) than Kittlitz's Murrelets. The bearing (angle between the ship's heading and murrelet) appeared to be less important than distance in explaining the probability of flushing. Approximately 50% of birds encountered within 400 m perpendicular distance from the ships' course flushed, while about 40% flushed at distances greater than 400 m. Time-to-event and hazard models were constructed to identify other potential variables that influence flushing distance.

## UPDATING AND TRACKING HABITAT LOSS WITH THE MARBLED MURRELET NESTING HABITAT SUITABILITY MODEL FOR BRITISH COLUMBIA

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The Marbled Murrelet nesting habitat suitability model for the British Columbia coast was developed in 2010 to estimate the amount and distribution of potential nesting habitat in Canada. The Canadian Marbled Murrelet Recovery Team's recommendation is to maintain at least 70% of the suitable nesting habitat that existed in 2002. The Model predicts the amount of suitable nesting habitat existing in 2002, providing a benchmark to measure the rate of habitat loss and success in achieving the 70% habitat maintenance goal. The habitat algorithm for the model incorporates mapped forest cover attributes of tree height and age that are important for nesting habitat. Spatial data of harvested cutblocks has recently become available from the provincial government and satellite imagery. Pre 2002 cutblocks were identified and removed from the Model to correct habitat estimates for 2002. Habitat losses totalled 6% on Crown Lands with the highest losses on Vancouver Island (11%). Two of the five conservation regions are approaching or have exceeded the thirty-year recovery habitat loss thresholds in ten years, suggesting an urgency to implement further habitat protection. The updated Model is recommended for broad-scale accounting of habitat, habitat losses, status assessments, and to aid in recovery and action planning.

## USING STABLE ISOTOPE RATIOS TO ASSESS HARLEQUIN DUCK PRODUCTIVITY

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Several sea duck species, including harlequin ducks (*Histrionicus histrionicus*), have experienced some declines over the past several decades. Harlequin declines appear to be due to recruitment being too low to offset mortality. Introduced fish may be contributing to low harlequin recruitment. Breeding harlequin density decreases with increasing fish diversity (number of species). In the presence of fish, aquatic invertebrates increase hiding, decrease drift and switch to nocturnal feeding behaviour, all of which decrease their availability as food items to harlequins. Fish presence also alters invertebrate community composition on harlequin breeding streams. These changes in behaviour and community assemblage may make it possible to determine the level of fish diversity on harlequin breeding streams through stable isotope analysis of harlequin body tissues. I combined data from two previous harlequin studies to examine the effect of fish diversity on stable isotope ratios of  $^{13}\text{C}$  and  $^{15}\text{N}$  in breeding harlequin blood and eggs. The ratios of  $^{15}\text{N}$  in adult female harlequin duck blood and eggs were significantly and positively correlated with fish diversity. As such, it may be possible to use stable isotope analysis to determine the level of fish diversity in streams on which harlequin adults have bred or juveniles have been raised from blood and feather samples collected on the wintering grounds. By comparing the proportion of adults to the proportion of juveniles breeding or being raised on streams at each level of fish diversity, it will be possible to calculate relative harlequin productivity at each level of fish diversity.

## STATUS OF THE BREEDING POPULATION OF BRANDT'S CORMORANTS (*PHALACROCORAX PENICILLATUS*) IN CENTRAL CALIFORNIA

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Brandt's Cormorants (*Phalacrocorax penicillatus*) are one of the most abundant and widespread breeding seabirds in central California (Point Reyes to Point Conception). In this region, breeding population sizes have been monitored with aerial photographic surveys since 1989, breeding success and other parameters have been monitored at the offshore South Farallon Islands (Farallones) since 1971, and breeding success has been monitored at three nearshore colonies since 1997. Historically, the Farallones colony has been the world's largest, with up to 12,000 pairs. This colony declined dramatically following the major 1982-83 El Niño. In the early 1990s, several new colonies emerged along the nearby mainland and increased rapidly, likely consisting partly of Farallon emigrants. In 1999-2007, Brandt's Cormorants increased dramatically throughout the study area concomitant with high breeding success. In the Gulf of the Farallones, overall numbers increased by 18% per annum in 1998-2006, including a resurgence of the Farallon colony. South of Point Piedras Blancas, the population expanded and numbers increased 9.9% per annum from 1989 to 2011. In 2008, however, numbers of nesting pairs declined dramatically in the northern portion of the study area (Gulf of the Farallones, Monterey Bay area) and have only partially recovered. Breeding success has been well below average since 2008. The decline appears to be associated with a crash in the local northern anchovy (*Engraulis mordax*) prey base. South of Monterey Bay, rapid recovery occurred after 2008, suggesting better prey resources and possibly immigration from colonies farther north.

## "STEPPING STONE" MIGRATION IN SOUTHWARD MIGRATING ARCTIC TERNS: THE APPARENT IMPORTANCE OF UPWELLING AREAS

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Arctic Terns (*Sterna paradisaea*) have long been lauded for their extraordinary migration between high northern hemisphere breeding grounds and Antarctic wintering areas. Until recently, little data existed to document this migration, and none existed for birds from the North Pacific. In this study, we tracked six Alaskan Arctic Terns tagged with combined light geolocation and saltwater immersion tags. During winter 2007-2008, these birds used 3 – 4 highly productive stopover locations to refuel during their southward migration: the California Current, the northern and southern Humboldt Current, and the Patagonian Shelf. Three of the birds went on to winter in the Weddell Sea region of Antarctica, where Arctic Terns from Atlantic populations are also known to winter.

Analysis of the first-ever post-breeding behavioral data collected on this species showed that the birds foraged only during daylight hours. Further, while they foraged throughout their southward migration, in some months they spent significantly more time foraging at stopover regions than while traveling. These important stopover regions occurred in areas of high ocean productivity, where foraging efforts would be expected to reap a greater reward.

## PASSIVE ACOUSTIC MONITORING OF NOCTURNAL SEABIRD POPULATIONS - COMPUTER-ANALYZED MEAN CALL RATE CORRELATES WITH ABUNDANCE AT WEDGE-TAILED SHEARWATER BREEDING COLONIES

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Almost half of the world's threatened seabird species return to breeding sites only under the cover of darkness, and most nest in underground burrows or in rock crevices. These factors along with their remote breeding colonies and low population sizes - make threatened seabirds notoriously difficult and expensive to monitor, further complicating their conservation. Here we explore a potentially transformative approach to monitoring the relative abundance of rare and elusive seabirds at breeding sites - automated acoustic monitoring. We tested the primary assumption of the approach, namely that rates of acoustic activity at seabird colonies are a valid index of relative abundance. We deployed Song Meter acoustic sensors at 13 Wedge-tailed shearwater (*Puffinus (Ardenna) pacifica*) breeding sites on Maui, Oahu, Lana'i, and Kaua'i in the state of Hawaii (USA) and counted the number of active burrows within 5m, 10m, and 20m of the sensors. Wedge-tailed shearwater acoustic activity (mean calls per minute quantified by spectrogram cross-correlation, an automated classification technique), was significantly correlated with the number of breeding burrows within 10m of the acoustic sensor ( $p < 0.05$ ). Our results are similar to a previous study showing a significant relationship between acoustic activity and colony size in diurnally active Forster's Terns (*Sterna forsteri*). Together, these studies indicate that acoustic monitoring can be an affordable, statistically powerful, and scalable approach to monitoring population trends for many of the world's threatened seabird species.

## RECENT TRENDS IN ALBATROSS BYCATCH RATES IN ALASKAN LONGLINE FISHERIES TARGETING GROUND FISH (2007 TO 2011).

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The most recent update (2007 to 2011) of the number of seabirds caught fleet-wide in Alaskan longline fisheries targeting groundfish shows an uptick in seabird mortality and a possible increasing trend in albatross mortality compared 2002 to 2006 - the period following adoption of to streamer lines. Recognizing that evaluating trends in seabird mortality from the number of seabirds killed can be confounded by changes in fishing effort, we estimated albatross bycatch rates by species, region, target species, and season using the actual haul sample (un-extrapolated) from North Pacific Groundfish Observer Program data for the Alaskan groundfish longline fisheries from 2007 to 2011. Annual trends in the total numbers of albatrosses caught mirrored annual trends in annual albatross bycatch rates. On average, albatrosses made up 2.2% of the catch. Though annual albatross bycatch rates differed by region, species, and target fish species, and monthly rates differed within and across target species, evidence of an increasing trend in albatross bycatch rates was not detected. The highest annual rates of albatross bycatch and the highest vessel specific albatross rates were detected in longline fisheries targeting sablefish. This finding justifies renewed outreach focused on the sablefish longline fleet. If annual reporting included albatross mortality rates derived from un-extrapolated observer haul data, trends in seabird bycatch (all species and species groupings) could be readily evaluated.

## DIRTY BIRDS: UTILIZING A NOVEL ANALYTICAL APPROACH TO INVESTIGATE PERSISTENT CONTAMINANT EXPOSURE TO BLACK SKIMMERS (*RYNCHOPS NIGER*) IN SAN DIEGO BAY

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Southern California's fragmented and urbanized coastal wetlands provide refuge for over 300 bird species, including the Black Skimmer (*Rynchops niger*). Critical habitats like San Diego Bay and Tijuana River Estuary are known to harbor high levels of contaminants from urban runoff. Persistent organic pollutants (POPs), including anthropogenic organohalogen compounds like polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs), occur throughout southern California's waterways and are known causes of numerous impairments in wildlife. Exposure to POPs has been the traditional focus of targeted contaminant analysis and is well documented in a wide range of fauna. An emerging area of research focuses on the bioaccumulative implications of non-targeted (naturally-occurring, unregulated, or emerging) compounds, yet little is known about their impacts to wildlife. By analyzing non-targeted compounds alongside targeted POPs, we may comprehensively assess true toxin burdens.

Black Skimmers exhibit poor reproductive output throughout the US, especially in southern California. Previous studies show skimmers accumulating contaminants in higher amounts than similar seabirds, possibly because they forage exclusively for top-schooling fish along coastal wetland margins susceptible to concentrated urban runoff. Using a novel GC×GC/TOF-MS non-targeted analytical approach, we identified and quantified both targeted POPs and non-targeted compounds of interest in presumed-viable and non-viable Black Skimmer eggs. Targeted compounds discovered in all egg samples included PCBs, PBDEs, DDT and its metabolites, and polycyclic aromatic hydrocarbons (PAHs). Mass spectrometry analyses of non-targeted compounds revealed novel contaminants of interest structurally similar to anthropogenic POPs.

## VISUAL ACUITY IN LEACH'S STORM-PETREL

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Leach's storm-petrels (*Oceanodroma leucorhoa*) are strongly attracted to dimethyl sulfide and can track prey rich areas by scent cues alone. Both prey capture style and prey size suggest that storm-petrels do not need high visual acuity (spatial resolution) for seizing prey. However, the ability to distinguish faint contrasts (high contrast sensitivity) and to see well in the dark (high absolute sensitivity) are advantageous for detecting prey items on or just below the surface of the sea. We investigated spatial resolution and contrast sensitivity of adult Leach's storm-petrels using a noninvasive behavioral test. Birds were positioned in front of computer monitors and presented with moving patterns of white and black gratings of different spatial frequencies, contrasts and intensities. At light levels corresponding to late afternoon (1.6 log cd/m<sup>2</sup>), storm-petrels had a spatial resolution of only 1.5 cycles/degree, which is the lowest value that has been reported for any avian species. By comparison this is similar to spatial resolution reported in rats, but 40 times lower than in humans and ~100 times lower than in Wedge-tailed eagles. However, storm-petrels detected contrast levels of ~10%, which is comparable to most other birds. At light levels corresponding to a starlit night (-4.4 log cd/m<sup>2</sup>), storm-petrels had maximum visual acuity of ~0.2 cycles/degree. Taken together, our results suggest that Leach's storm-petrels cannot rely solely on vision to recruit to foraging flocks, however their visual capabilities are sufficient for seizing prey at night, providing there is some moonlight.



## MARBLED MURRELET NEST-SITE CHARACTERISTICS IN ALASKA

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Information on the characteristics of Marbled Murrelet (*Brachyramphus marmoratus*) nest sites in Alaska has been limited given few known nest locations. Recent telemetry research and fortuitous discoveries since the mid-1990s has almost tripled the number of known nest sites (from 40 in 1995 to 106 in 2012). Of the nests with known locations, about half (55%, 52 of 95 nests) were located on the ground on ledges of steep, rocky cliffs or on mossy ledges above creeks; all others were on branches of older-aged trees. Of the nests with detailed characteristics, most were in areas with high overhead cover, provided by surrounding vegetation, tree branches, or rocks. Mean nest elevation was 333 m (range 7-1898) and distance to nearest saltwater was 7 km (range 0-52 km); recent nests occurred at higher elevations and further inland than previously reported, with overlap in location and habitat characteristics with the closely related Kittlitz's Murrelet (*B. brevirostris*). Most nests with known outcomes were unsuccessful (68%; 41 of 60 nests) and nest failure was most common during incubation. Recent mapping of Marbled Murrelet habitat in Alaska included older-aged forests and some rocky habitat from Prince William Sound westward; this mapping needs to be expanded to include rocky cliffs throughout Alaska and second growth forests where cliffs occur adjacent to creeks. Changes in the extent of forested areas with climate change may impact nesting habitat availability as warmer temperatures could affect microclimate and cover, which are key characteristics for nesting substrate and protection from predators, respectively.

## IMPROVEMENTS IN OILED SEABIRD REHABILITATION - USE OF INFRARED THERMOGRAPHY

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There have been many advances in improving the process of oiled bird rehabilitation in recent years. We investigated a novel application of non-invasive infrared (IR) thermography to determine thermal balance and plumage integrity of seabirds during rehabilitation. During an oil spill response, there is a need to quickly move seabirds from pens to pools to prevent captivity-related foot and keel injuries. Regaining thermal balance post-wash is a critical first step for pelagic species; they must regain plumage waterproofing by re-aligning feathers and preening to prevent water from penetrating to the skin. The current practice of checking waterproofing requires frequent handling, is time and labor intensive, is stressful for birds, and disrupts the physical alignment of the feathers, which the birds must expend extra energy to re-align. We tested the use of the IR camera to assess post-wash waterproofing in oiled (n = 7), fouled (n = 2) and non-oiled/fouled (n = 5) seabirds at two rehabilitation centers. Thermographs were compared with traditional (physical) waterproofing assessments to assess the efficacy of IR thermography. Of 20 waterproof-checking sessions conducted, the handler's assessment of waterproofing and the interpretation waterproofing by analyzing the thermograph had a 76% agreement rate, a 24% disagreement rate. Although thermography was effective for assessing ventral waterproofing, the heat signature may be compromised by some handling techniques, accounting for most of the discrepancies between the human and IR assessments.

## HOTSPOTS OF SEABIRD AGGREGATIONS DURING SUMMER IN THE WESTERN NORTH PACIFIC

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Marine ecosystems have been exploited and altered through the anthropogenic impacts in the global ocean. The North Pacific Transition Zone (NPTZ) is one of the important fishing grounds for tuna, squid, and saury, and also provides important feeding habitats for seabirds including endangered species. For ecosystem-based management, understandings of interactions between high trophic consumers including fisheries, and fluctuations in the dynamic ecosystem are needed. We explored high use areas of multispecies of seabirds as proxies for biological hotspots in the NPTZ. Sight-counting surveys were conducted in July and October 2010, and September and October 2011 onboard the Shunyo-maru. First, we developed single-species predictive models for 10 species including albatrosses, shearwaters, and storm-petrels using remotely sensed satellite oceanographic data (sea surface temperature, chlorophyll *a* concentration and sea surface height anomaly), bathymetry and distance from the coast. We used a modeling method based on maximum entropy implemented in MAXENT using presence data of seabird. Single-species high use areas (more than 50 % probability) were then combined to detect multispecies aggregation hotspots. Single-species model showed that each species exploited different suitable habitats. However, we found some aggregation areas of multispecies also. These aggregation areas might reflect the variety of key prey species at different trophic levels such as zooplankton and fish. Our results can help to monitor fluctuations in the dynamic marine ecosystem and to design effective management plans.

## CHRONIC (*ASPERGILLUS*) EXPOSURE AS AN UNDERLYING CAUSE OF GULL MORTALITY AT THE URBAN-WILDLIFE INTERFACE OF SAN FRANCISCO BAY, CALIFORNIA

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The Pier 94 restored wetland and adjacent area of South San Francisco Bay, California has exhibited apparent elevated gull (*Larus* spp.) mortality for at least 10 years. Initial necropsy findings indicated that causes of mortality were multifactorial, including feather fouling by grease and exposure to anticoagulant rodenticides. However, after measures were taken to mitigate these factors, mortalities remained high and systemic aspergillosis became a primary diagnosis on many of these birds. Consequently we quantified fungal loads in multiple areas frequented by gulls at or near Pier 94 in order to identify potential high risk areas for (*Aspergillus*) spp. exposure. Our results indicate that “urban” areas had significantly higher total fungal, (*Aspergillus*) spp. and (*A. fumigatus*) counts than “natural” sites and that the recycling and dump sites with enclosed areas of large amounts of organic material presented the biggest risk of exposure to high levels of (*Aspergillus*) to gulls at this urban interface.

## EXPERIMENTAL EVALUATION OF MULTIPLE BYCATCH MITIGATION MEASURES ON PELAGIC LONGLINE OPERATION IN WESTERN NORTH PACIFIC

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In order to reduce incidental mortality of seabirds in fisheries, it is essential to develop and introduce effective mitigation measures that are evaluated scientifically. In the North Pacific; however, there are few scientific studies addressing the effectiveness of mitigation measures. We compared the effectiveness of hybrid tori-lines (single vs. double) with and without weighted branchlines to a control of no mitigation. Weighted branchlines were the Yamazaki double-weight configuration reported effective and safe in the southern hemisphere pelagic longline. We carried out 64 longline operations (61,440 hooks in total) in the western North Pacific from December 2011 to June 2012. Each operation (set) of 960 hooks was divided into six experimental treatments: single, double or no tori-lines coupled with weighted and unweighted branchlines. Metrics of evaluation were the attack rate of seabirds on baited hooks and the bycatch rates the most vulnerable seabirds to longline mortality the North Pacific, Laysan and black-footed albatross. Three albatross and five shearwater species attended line setting and 107 Laysan and 21 black-footed albatrosses were by-caught. Nearly all attacks were eliminated within 75 m of the stern when single or double tori-lines were deployed and the bycatch rate of albatrosses were reduced by 96-100% compared to non-tori line controls. Weighted branchlines without tori-lines also reduced bycatch rate but less than the tori-line treatments (40%). These results suggest that deployment of well-designed tori-lines dramatically reduce albatross bycatch by pelagic longline fisheries in the North Pacific, and therefore are recommended as best-practice seabird mitigation for these fisheries.

## DISTRIBUTION OF SUBADULT SHORT-TAILED ALBATROSS IN THE NORTH PACIFIC

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Limited data from previous studies indicates that the distribution of subadult ( $\leq 3$  years), especially juvenile, short-tailed albatrosses (*Phoebastria albatrus*) is considerably different than adults. Furthermore, these younger birds have a greater incidence of bycatch in commercial fisheries (eight of ten documented bycatch mortalities were subadult birds). We tracked 41 juvenile birds for up to two years post-fledging (n=41,689 locations) between 2008 and 2012. We examine travel patterns and spatial use between demographic and temporal variables. Preliminary findings show variations in travel (km/day) between first and second year birds as well as between seasons. Spatially, subadults spend much of their time in the Bering Sea concentrated around canyons, but travel as far from their source colonies in Japan as the United States west coast. High use areas occur mostly within national and international fisheries and less within multi-national fisheries. Regionally, there are observed variations between bird demographics. Across sexes, canyon use and overall range are not uniform. Across source colonies, we observe some variations in the Sea of Okhotsk and eastern Pacific between hand-reared birds from Mukojima and naturally-reared birds from Torishima. Our findings demonstrate demographic, seasonal, and regional variations in the distribution of subadult short-tailed albatross in the North Pacific. These findings will help inform Alaskan fishery managers and current marine spatial planning efforts.

CONSERVATION AND PUBLIC EDUCATION OF THE JAPANESE MURRELET  
(*SYNTHLIBORAMPHUS WUMIZUSUME*) AT BIROJIMA AND KADOGAWA-CHO, MIYAZAKI-  
KEN, JAPAN

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Birojima is the largest breeding colony of the Japanese Murrelet (*Synthliboramphus wumizusume*) in the world and is located near the town of Kadogawa-cho, northern Miyazaki-ken, Japan. Extensive studies by Nakamura, Ono and Fries in 1989-1995 indicated the global importance of this colony, the intriguing biology of Japanese Murrelets, and the significant problem of heavy crow (*Corvus macrorhynchos* and *C. corone*) predation related to surf fishing. Since 1992, the Kadogawa-cho government has implemented several important conservation actions and public education to protect Japanese Murrelets at Birojima. Surf fishermen are encouraged through signs and information to: (1) stay below vegetation to avoid trampling breeding habitats; and (2) remove bait and garbage after fishing which attracts crows to the island which prey on murrelet eggs and adults. These actions have been highly effective for keeping fishermen out of breeding habitats and moderately effective for reducing bait and garbage but continued efforts are needed. No reduction in surf fishing has occurred and future bird watching also will assist the local economy. In addition, education efforts in 1992-2012 have resulted in local people knowing, appreciating, and being proud of the Japanese Murrelet. A new education program will start in 2013 that will assist future conservation actions. In 2005, the Japanese Murrelet became the official town symbol which has many values for expanding conservation actions and education in the future. Future needs include: (1) long-term murrelet monitoring program; and (2) contingency plans and educational materials for responding to oil spills, fires, and introduced predators at Birojima.

THREE-DIMENSIONAL SPATIAL USE OF MARINE HABITATS PROVIDES INSIGHT INTO THE  
CONTRASTING POPULATION TRENDS OF A DEEP-DIVING SEABIRD IN THE BERING SEA

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We investigated the response of thick-billed murres (*Uria lomvia*) to food shortages at two Bering Sea shelf colonies with contrasting population trends. Given their high flight costs, we hypothesized that murres at St. Paul Island (declining population) would be less resilient to food shortages on the shelf because the colony is located farther from oceanic habitats than St. George Island (stable population). We combined measures of spatial (GPS-tracking) and vertical (TDR-diving) use of foraging habitats, diets, chick feeding frequency, fledging success and adult nutritional stress. During the study (2008-2010), birds

from St. Paul foraged on the Middle Shelf (100-m depth), and conducted longer and deeper dives during extended daytime trips than St. George birds. Although no colony differences were found in either total distance traveled and diving effort overnight, birds from St. George fed on high-lipid prey on the Outer Shelf and Slope ( $\geq 200$  m). There was negligible nocturnal diving activity in the Middle Shelf suggesting that birds from St. Paul were more time-restricted for self-feeding. Chicks from both colonies were fed with similar frequency on prey of comparable quality and size, and consequently experienced similar rates of fledging success. Nevertheless, the higher foraging effort and lower quality prey consumed by birds from St. Paul resulted in higher levels of nutritional stress. Given that nutritional stress appears to be a good predictor of adult survival, we propose that chronic reduction in food availability on the Middle Shelf may in part explain the contrasting population trends of thick-billed murres at the Pribilof Islands.

## BASELINES AND WRECKS: DEFINING WHAT'S NORMAL

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Wrecks - or anomalously high die-offs - of seabirds grace beaches throughout the world. By contrast, baselines are "normal" patterns in space and/or time. Beached bird programs rely on demonstrating both; in fact, baselines allow definition of abnormality, including wrecks. Or do they? In the Pacific Northwest, the Coastal Observation and Seabird Survey Team (COASST) is one of several beached bird programs collecting monthly data from beaches in northern California north to the Arctic Circle in Alaska. Within the Pacific Northwest (CA, OR, WA) outer coast, almost 50% of reported finds are two species: Common Murres, (*Uria aalge*), and Northern Fulmars, (*Fulmarus glacialis*), occurring by the thousands on beaches in the late summer-fall (July-October) and fall-early winter (October-December), respectively. Wrecks of these birds, defined by anomalously high peaks relative to long-term averages, are common at the "right" and occasionally wrong times of year, for instance during the early spring (February-March). Other species wreck at much lower intensities and over much smaller spatial extents, albeit at orders of magnitude more than their "usual" occurrence. Given this range in space, time, and taxonomy, is there a meaningful way to describe wrecks, and differentiate them from baselines? We used the COASST dataset to examine die-offs as a function of species rarity (indexed by overall occurrence in our dataset), timing (calendar months), location (COASST region), intensity (as a function of the long-term average), and cause (if known). We suggest that grading wrecks by the intersection of timing and location allows a management-relevant assessment of whether observed wrecks are catastrophes, or just mortality as usual.



## CORTICOSTERONE IN FEATHERS – A CAUTIONARY TALE OF NUTRITIONALLY-STRESSED CASPIAN TERN CHICKS

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Stressful environmental conditions affect the adrenocortical function of developing animals, which can have consequences for their fitness. Recent discovery of the avian stress hormone corticosterone (CORT) in feathers could broaden the application of endocrine research in ecological and evolutionary studies of wild seabirds. Mechanisms of CORT deposition in feathers are not well known; the prime hypothesis postulates that the deposition of feather CORT is a passive process reflecting blood levels of the hormone during feather growth, but so far there have been few attempts at biological validation of the relationship between feather CORT and plasma CORT. We tested this relationship in Caspian Tern (*Hydroprogne caspia*) chicks experimentally exposed to moderate levels of nutritional stress during feather development. Plasma CORT was higher in nutritionally-stressed chicks compared to controls fed *ad libitum*. Feather CORT was higher in controls, however, than in nutritionally-stressed individuals. Feather CORT was positively related to maximum plasma CORT levels, but only within diet treatment groups. Feather CORT was strongly and positively related to feather growth rates. This is the first experimental study to show that feather CORT can be reduced in response to nutritional stress, even though plasma CORT concentrations were elevated. Results indicate that feather CORT deposition is more complex than previously thought and the congruence between plasma and feather CORT levels cannot be assumed.

## USING ARTIFICIAL ISLANDS AND SOCIAL ATTRACTION TO ESTABLISH NEW CASPIAN TERN COLONIES IN THE UPPER KLAMATH BASIN, CALIFORNIA

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We investigated the efficacy of building artificial nesting islands and using social attraction for establishing new Caspian Tern (*Hydroprogne caspia*) breeding colonies in the Upper Klamath Basin, California. Before the 2010 breeding season the Army Corps of Engineers constructed three artificial islands in the Upper Klamath Basin. We used decoys and recorded vocalizations to attract Caspian Terns to nest on these new islands. Caspian Terns attempted to breed at each new island in the first year with social attraction. There was a significant increase in the total number of Caspian Terns breeding in the Upper Klamath Basin following creation of new nesting islands. A total of 258, 222, and 419 pairs of terns attempted to nest on the new islands during 2010, 2011, and 2012, respectively. During the first three years, reproductive success of terns at all three islands combined was 0.65, 0.10, and 0.33 fledglings/breeding pair. Competition with California and ring-billed gulls (*Larus californicus* and *L. delawarensis*) for nesting space, nest predation by gulls, low water levels, and nocturnal predators were factors limiting colony size and productivity. Habitat creation and social attraction can be effective restoration techniques to establish new breeding colonies where nesting habitat is a limiting factor; however, effective management of other limiting factors (e.g., control of on-colony predators and competitors) will likely be necessary to promote the development of persistent, self-sustaining breeding colonies on these artificial islands.

## TAKING THE PULSE OF PUGET SOUND: DEVELOPING A MARINE BIRD INDICATOR FOR ASSESSING ECOSYSTEM HEALTH

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In Puget Sound, WA, hundreds of research and management actions are underway to protect and restore the ecological health of the Sound by 2020 as part of a state-led ecosystem management plan. Puget Sound is a large inlet of the Pacific Ocean and an important marine bird area. Over 100 species of seabirds breed, migrate and/or overwinter in Puget Sound. We were tasked to develop a “marine bird” indicator that reflects the health of marine bird populations in Puget Sound. We evaluated existing bird indicators in Washington and used criteria to arrive at an indicator that was 1) ecologically meaningful and Sound-wide and 2) supported by existing time series and data with enough power to detect trends. All indicators we evaluated had caveats. Based on our evaluation, the best indicator was “density trends during spring and summer for seabirds breeding in Puget Sound and that are highly dependent on the marine environment of Puget Sound, including pigeon guillemot, rhinoceros auklet, and marbled murrelet”. While some fraction of the breeding population may not be in Puget Sound during winter months and there is some habitat and diet overlap between these species, there are some notable differences and a 12-year dataset is available. Choosing measureable and meaningful indicators is an essential component of ecosystem-based management including marine spatial planning processes that use EBM frameworks. Indicator selection can be challenging and needs to consider a variety of factors including how the indicator will be used, what it indicates and practical data considerations.

## A MODEL APPROACH FOR ESTIMATING BURROW NESTING SEABIRD COLONY SIZE, TRENDS, AND HABITAT ASSOCIATIONS

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We present a Prototype monitoring strategy for estimating burrow density and number of occupied burrows for burrow-nesting seabirds. We use data and management questions from Washington State, USA, as an example that can be applied to an array of burrow-nesting seabird species at single- or multi-island scales. We also demonstrate how habitat assessments can be conducted concurrently. Specifically, we compared Rhinoceros Auklet (*Cerorhinca monocerata*) burrow density and occupancy among nesting colonies in the California Current and the Salish Sea and between the 1970s, 1980s and today. We estimate there are 36 152; 1 546; and 6 494 occupied burrows on Protection and Smith islands (Salish Sea), and Destruction Island (California Current), respectively. Our Salish Sea estimates were 52% greater than those from the 1970s and 1980s, while the California Current estimate was 60% less than that from 1975. This suggests that the Salish Sea population has increased, despite greater human impacts in that ecosystem. However, some of the estimated changes between time periods could be the result of methodological and analytical differences. To address these issues we recommend an unbiased and representative sampling approach (stratified random) and an approach for optimally allocating the samples among strata within and among islands, depending on the scale of the question being addressed. Optimally allocating the sample would save a great deal of field effort; using this approach, we achieve relatively high power (> 0.80) to detect moderate changes (20%) sampling hundreds of fewer plots than a non-optimally allocated sample.

## CURRENT STATUS AND FUTURE DIRECTIONS OF MARBLED MURRELET SCIENCE AND CONSERVATION

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Conserving marbled murrelets is uniquely challenging because of the species' secretive nesting behavior and reliance on both older forests and near-shore coastal ecosystems. Nevertheless, conservation efforts have been aided by the progression of murrelet research from natural history descriptions to increasingly sophisticated ecological studies. The development of radio-telemetry techniques has facilitated the location of significant numbers of active nests, which has led to greater understanding of murrelet breeding biology. Telemetry information has also been invaluable for characterizing at-sea movements and seasonal changes in distribution. Moreover, technological advances in remote sensing and radar technologies have dramatically improved researchers ability to characterize murrelet marine and terrestrial habitats. Numerous population genetic studies have been conducting using neutral markers, all of which indicate that murrelets breeding in the Aleutian Islands and central California are distinct from a larger central unit spanning northern California to mainland Alaska. However, a recent study suggests that local adaptations occur within the US threatened portion of the murrelet's range, and that the loss of local populations in this region could compromise the evolutionary potential of the species.

At-sea and terrestrial monitoring programs have detected regional-scale population declines in many parts of the murrelet's range, although movements among populations can complicate the interpretation of survey data. Halting population declines by increasing reproductive and survival rates will be critical for preventing extirpations. In some areas, causes of historic and ongoing population declines have been identified with reasonable confidence facilitating recovery measures, but factors limiting murrelet populations remain unknown in many regions. Needed are (1) studies explicitly designed to evaluate the relative importance of potential limiting factors, and (2) quantitative assessments of factors causing nest failure and adult mortality throughout the annual cycle. More complete knowledge of murrelet diet will be critical for understanding the role of marine factors in population declines. Other opportunities for research include the development of telemetry-based methods that provide unbiased estimates of reproductive rates and ecological studies of nest predators, particularly corvids.

In conclusion, the marbled murrelet can be considered an indicator of the health of old-growth and near-shore coastal ecosystems, and extinction from these ecosystems would represent a significant symbolic loss. Maintaining viable murrelet populations will require the sound integration of management and science, proactive conservation measures, and the concerted efforts of all stakeholders.

## POST-BREEDING DISTRIBUTION OF ANCIENT MURRELETS IN THE BERING AND CHUKCHI SEAS

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Ancient Murrelets (*Synthliboramphus antiquus*; ANMU) are the most abundant *Synthliboramphus* murrelet and their colonies are widely distributed across the North Pacific basin. In Alaska, they breed on islands in the southeast and in the Aleutian Islands, but little is known about their post-breeding dispersal. We used pelagic surveys to examine seasonal changes in ANMU distribution in Alaska. Surveys were conducted from 2006-2012 aboard research vessels of opportunity in the Gulf of Alaska, Bering Sea,

Chukchi Sea, and Beaufort Sea, totaling over 158,000 km of effort. During the spring (March – May), ANMU were found along the Aleutian Islands and in the northern Gulf of Alaska. During the summer breeding season (June – 15 August), ANMU were found in the southern Bering Sea middle and outer shelf waters, primarily in late July and August. In the fall post-breeding season (16 August – October), ANMU were recorded in the Bering Sea middle and outer shelf waters and north into the northern Bering Sea and Chukchi Sea as far as 73.02°N. During this time, the greatest numbers were observed in September and October in Norton Sound (northeastern Bering Sea), a shallow area with abundant forage fish and euphysiids. In the Chukchi Sea, they were also observed in association with euphysiids. We speculate that the birds seen in the northern Bering Sea and the Chukchi Sea are post-breeding migrants from the Aleutian Islands, and possibly from the Russian coast, taking advantage of abundant prey in those areas in the fall.

#### ACTIVITY PATTERNS OF AUDUBON'S SHEARWATERS BREEDING IN THE BAHAMAS

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In highly pelagic seabirds, activity at sea can be influenced by breeding stage and environmental variables. Although analysis of activity patterns derived from global location sensing (GLS) data are becoming more commonplace, few data are available for shearwaters. We examined the activity patterns of Audubon's Shearwaters (*Puffinus lherminieri*), testing for differences in behavior of adults within and between successive breeding and non-breeding seasons. We tested for activity trends in response to breeding stage and moon phase. Wet/dry activity data were collected using geolocators attached to leg bands of Audubon's Shearwaters. Across stages, we found that the proportion of time spent on the water was significantly greater than the proportion of time spent flying or on land. However, preliminary analysis did not support evidence of differences in activity between pre-laying, incubation and chick-rearing stages. Preliminary analysis of spatial data suggests that duration of time spent at sea for breeding birds increases during moonlit nights. The relationship was strongest during nights when moonrise occurred before midnight and a high fraction of the moon was illuminated. Our study provides new insight into the activity patterns of Audubon's Shearwater.

#### INTERPOPULATION VARIABILITY OF CRESTED AUKLETS (*AETHIA CRISTATELLA*) BASED ON GENETIC AND MORPHOMETRIC DATA

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Crested auklets are a small seabird with bright plumage ornamentation and complex social behavior that breeds on the islands and coastlines of the Bering and Okhotsk seas. Outside the breeding season, auklets spend time at sea, and nothing is known about dispersion of young birds. Here we tested the morphometric and genetic variability of birds from different colonies. We collected data at Buldir I., Aleutians (June-July 1993), around the Kuril Islands (May-July 1997), in north-eastern waters of Kamchatka (May-June 1997-1998), at St. Lawrence I. (July-August 2001), at Talan I., the Sea of Okhotsk

(June-July 2008-2010), at Saint-Jonah (Iona) I., the Sea of Okhotsk (July 2009) and at Medny I., the Commander Islands (June-July 2011-2012). We measured body weight and wing, tarsus, bill, crest, auricular plume lengths (totally 310 birds from 5 colonies were analyzed). We conducted genetic analysis of the control region (408 b.p.) of mitochondrial DNA and 5 microsatellite loci (total 116 samples from 5 colonies were analyzed). One-way ANOVA with post-hoc Tukey test showed negligible effect of “population” on measured morphometric variables of birds ( $p > 0.05$  for most of comparisons). Also, no genetic differentiation between colonies was found. A high haplotypic ( $H = 0.994 \pm 0.002$ ) and relatively low nucleotide diversity ( $0.013 \pm 0.007$ ) were noted for all groups of auklets based on this mtDNA fragment, which is probably related to ecological peculiarities of the species and the history of formation of these colonies. We suppose that crested auklets from different colonies could spend winters in mixed flocks, and the gene flow between colonies could be very intense.

## USING REMOTE CAMERAS TO MONITOR MONTANE SEABIRD BURROWS IN KAUA'I

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Monitoring the activity and fate of active nocturnal seabirds at breeding burrows can present a whole range of challenges, particularly if burrows are in remote locations or in habitats where repeated visits can result in significant damage to surrounding vegetation. We considered the use of remote cameras as a way to monitor Hawaiian Petrel *Pterodroma sandwichensis* and Newell's Shearwater *Puffinus newelli* burrows on the island of Kaua'i during the 2012 breeding season. Over the course of the season, a total of 10 Hawaiian Petrel and 14 Newell's Shearwater burrows were monitored using Reconyx Hyperfire PC900 cameras from the onset of the breeding season until they either fledged or failed. Reconyx cameras were chosen due to the fact that the infrared facility produced no glow (thus reducing disturbance) and trigger speed was extremely rapid producing images that were of near-video speed. Cameras recorded as yet unseen behaviour, as well as providing data on adult attendance, timing of arrivals and departures, amount of time spent outside of burrows (an important factor to consider in terms of vulnerability to predation), emergence period for juveniles, and fledging dates. Data was also collected on the prevalence of introduced predators at active burrows, with the vast majority visited by rats (*Rattus exulans* and *R. rattus*) and two visited by feral cats. A rat predation event was also caught on camera. Cameras proved to be an extremely useful tool for monitoring the target species. Limitations and logistical issues should however be considered and these are discussed.

## MARINE AND TERRESTRIAL INFLUENCES ON SPATIAL AND TEMPORAL DISTRIBUTION OF THE MARBLED MURRELET IN THE PACIFIC NORTHWEST

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The Marbled Murrelet (*Brachyramphus marmoratus*) is a small, diving seabird in the alcid family that forages within nearshore marine waters and nests on limbs of old coniferous trees. The species is federally listed as Threatened in the USA in the states of Washington, Oregon and California. As part of the regional effectiveness monitoring program in support of the Northwest Forest Plan, we have been



surveying murrelets along coastal waters from year 2000 to present. These surveys indicate that murrelet numbers are declining at an annual rate of about -2.2%. Concurrent modeling of murrelet nesting habitat indicates an overall decline in amount of suitable nesting habitat of about 0.5%/yr, due mostly to logging on non-federal lands and wildfire on federal lands. Furthermore, the spatial distribution of murrelets is strongly correlated with amount of adjacent suitable nesting habitat. Population decline could be due to losses of nesting habitat, but marine conditions could also be responsible. If marine conditions are the driver of population change, then we would expect other marine birds with similar foraging ecologies to experience similar population declines but we found no comparable declines among other alcid species. Circumstantial evidence leads us to conclude that the conservation and restoration of nesting habitat are keys to recovery of this species.

## WAKE ATOLL ECOLOGICAL RESPONSES 8 YEARS AFTER CAT ERADICATION

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Feral cats (*Felis catus*) had been present on Wake Atoll since the late 1960's and numbered fewer than 200. Years of predation pressure eliminated small seabirds and suppressed rat populations. Since 2004, Wake Atoll has been free from cat predation, and seabirds have responded accordingly. A survey in 2012 found Wake to hold the largest colony of Christmas Shearwaters (*Puffinus nativitatis*) in Micronesia; and new records for Red-billed Tropicbird (*Phaethon aethereus*) and Little Tern (*Sterna albifrons*), a potential breeder. Tropicbirds and noddies have increased several-fold, while albatross have not increased from their mere presence. In addition, the island has experienced a suite of significant man-made and stochastic events, including a Super Typhoon, forest clearing to ease Bird Strike issues and rodents (*Rattus spp.*) reaching pestilent levels. After years of research, the U.S. Air Force, U.S. Fish and Wildlife and Island Conservation conducted an aerial rat eradication in June 2012. The ongoing project will require two years of monitoring before the eradication result is determined.

## TAKING A TERN FOR THE WORSE? WHEN DO WE RAISE A RED FLAG FOR *O. ALEUTICUS*?

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The Aleutian tern (*Onychoprion aleuticus*) is a little-studied colonial seabird nesting in coastal areas of Alaska and eastern Siberia. Estimates of population size in Alaska are >20 years old, and include counts differing by at least two decades at various colonies. Estimates using the best available data range from 9,000 to 13,000 birds, with the largest colonies occurring in Yakutat, the Copper River Delta, and Kodiak Island. Anecdotal evidence suggests substantial declines in all of these areas as well as the Aleutian Islands. Unfortunately, data are generally lacking, and trends are difficult to evaluate because of the species' dispersive colonizing tendencies. Unlike most colonial nesting seabirds in Alaska, major population concentrations fall within multiple land management units, a fact that has discouraged broadscale surveys. Here we summarize current information on size and location of Aleutian tern colonies in Alaska, and invite discussion about whether data are sufficient to promote this as a species of concern. We also call attention to the need for a comprehensive statewide survey for the species.

## CONTAMINANTS IN SEABIRDS: PAST, CURRENT, AND FUTURE RESEARCH AND CONSERVATION PRIORITIES

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Accumulation of DDT and its derivatives (DDTs), other chlorinated 'pesticides' and polychlorinated biphenyls by seabirds in the 1960s, and detection of DDTs in Adelie Penguins in Antarctica, prompted the emergence of a new conservation priority – the ending or control of the uses of these toxic substances. That priority has now been addressed. New classes of potentially harmful contaminants, however, have appeared, including brominated fire retardants. That they have also become contaminants in human bodies indicates that their future use will be curtailed. DDE remains a contaminant in every seabird and every bird of prey in the world. With, however, the apparently sole exceptions of the California Condors breeding in coastal central California and some of the Peregrine Falcons of the California Channel Islands, reproduction is at normal levels, an indication that there are threshold levels of DDE for each species. Above these levels, reproduction is depressed, but below them reproduction is normal. If not sprayed on marshes, forests or cotton fields where it would kill a large fraction of the local biota, DDT could continue to be used in relatively small amounts for indoor spraying in the anti-malarial programs such that environmental levels of DDE do not exceed the threshold of effect to sensitive avian species.

The discharge of an estimated 2,000 tons of DDT into the marine environment of southern California from an industrial source provided a high level of exposure that resulted in severe shell thinning and reproductive failures. Elsewhere, lower exposures to DDTs from nearby terrestrial sources resulted in a lower degree of eggshell thinning in local populations of seabirds, including Common Murres and Ashy Storm-Petrels on the Farallon Islands and Northern Gannets on Bonaventure Island. It has long been an operating assumption among NOAA personnel that PCBs have /have had harmful effects on the seabirds of the Southern California Bight but supporting evidence has not been forthcoming. This assumption appears to be based more on a concept of political correctness rather than on a scientific analysis of all available data and other information. Harmful effects of higher levels of PCBs have been documented, however, on arctic-breeding Glaucous Gulls that feed in part on the carcasses of marine mammals.

Over most of the Pacific, the sum of PCB congeners in any component of the marine environment, including seabirds, is generally about three times higher than the concentration of DDE. The relative concentrations are reversed in coastal California. Ratios much lower than three:one generally indicate therefore that a portion of the residues have come from California coastal waters.

A convincing demonstration of a harmful effect on a seabird species of anthropogenic mercury in the marine environment would be welcome.

## SUBLETHAL EFFECTS OF MERCURY AND PCBS ON BREEDING LEAST TERNS (*STERNULA ANTILLARUM*)

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We studied six least tern (*Sternula antillarum antillarum*) breeding colonies in locations spanning the entirety of the Georgia coast from 2011-2012 to assess the impacts of mercury and polychlorinated biphenyls (PCBs) on least tern health and reproduction. An estimated 200 tons of mercury and the PCB Aroclor 1268, which are persistent pollutants that biomagnify in the food web, were released at the LCP Superfund site in Brunswick, GA, from 1919-1994. Least terns are piscivorous, colonially nesting, migratory seabirds that forage close (< 5 km in GA) to breeding colonies. We assessed the effects of concentrations of mercury ([Hg]) and Aroclor 1268 in feces, feathers, and eggs, on egg volume and weight, eggshell thickness, fluctuating asymmetry (FA) of various morphometric measurements, chick growth rate, and various blood cell counts associated with immunosuppression. Aroclor 1268 and mercury were elevated in samples across the GA coast, which had not been previously reported, particularly with Aroclor 1268 whose sole eastern U.S. point source is LCP. Analysis is underway, but thus far egg Aroclor had an effect on eggshell thickness ( $p = 0.01$ ); feather mercury affected chick tarsus FA ( $p = 0.02$ ), primary feather FA ( $p = 0.01$ ), and wing chord FA ( $p = 0.02$ ); and fecal mercury affected chick heterophil/lymphocyte ratios in blood ( $p = 0.02$ ). We also will discuss complete colony failure due to intense predation, mostly by coyote (*Canis latrans*) and raccoon (*Procyon lotor*), in our first season, and the increase in colony success in the second season after electric fencing was implemented.

## YEAR-ROUND SPATIAL AND TEMPORAL DISTRIBUTION OF A SMALL, DIVING SEABIRD, THE CRESTED AUKLET (*AETHIA CRISTATELLA*), ORIGINATING FROM A BREEDING SITE AT BULDIR ISLAND, ALEUTIAN ISLANDS

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Year-round seabird ecology and behaviour is poorly understood due to difficulties associated with monitoring their at-sea distribution during the non-breeding season in often harsh and remote environments. However, the development of increasingly small and light remote-sensing devices has permitted tracking of bird movement across large oceanic distances for long periods of time. To examine the movement of a small, diving seabird, we deployed miniaturized, tarsus-mounted geolocators (Lotek LAT2900, 2 g, <1% body mass) on 31 Crested Auklets (*Aethia cristatella*) in 2011, from a breeding colony at Buldir Island, Aleutian Islands, AK. We recovered 10 geolocators (32% recovery) in 2012, and data revealed, for the first time, migration routes and important wintering areas for Crested Auklets breeding at a western Aleutian Island. We have found that immediately following the breeding season, tagged individuals migrated c.1400 km north to the Gulf of Anadyr, and Bering Strait. In December, they travelled c.3400 km directly south-west to productive waters off the Kuril Islands and Hokkaido, Japan, finally moving c.2300 km east to Buldir Island in April. Prior to our study, knowledge of Crested Auklet winter distribution was limited to haphazard at-sea boat surveying. Our novel research, revealing an unexpected triangular, long-distance migration pattern, has provided encouraging preliminary results for the feasibility of tracking small, heavy wing-loaded auks using archival-light geolocators, and has potentially identified ecologically important areas for planktivorous seabirds breeding in the Western Aleutian chain of Alaska.

## ASHY STORM-PETREL, CASSIN'S AUKLET, AND SCRIPPS'S MURRELET BANDING AT CALIFORNIA'S CHANNEL ISLANDS: PAST, PRESENT, AND FUTURE.

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The Montrose Settlements Restoration Program was created to restore resources impacted by organochlorine contamination in the Southern California Bight. Seabirds are one focus of this restoration program and several projects have been initiated to benefit seabird species. Projects targeting Ashy Storm-Petrels (*Oceanodroma homochroa*), Cassin's Auklets (*Ptychoramphus aleuticus*), and Scripps's (formerly Xantus's) Murrelets (*Synthliboramphus scrippsi*) began at Channel Islands National Park in 2006. Concurrent monitoring for these species has occurred at four Park islands: Anacapa, Santa Cruz, San Miguel (Prince), and Santa Barbara. One component of this project has consisted of mark-recapture work, mainly using metal leg bands, to gain insight into aspects of demography which can affect restoration and remain unknown for these species. Metal leg bands were applied to adult and sub-adult Ashy Storm-Petrels captured in mist-nets and to chicks found in natural and artificial nest sites. Additionally, Passive Infrared Transponder tags were applied to chicks to examine recruitment, age of first breeding, and longevity. Cassin's Auklet chicks and adults found in artificial nest sites were banded to assess population trends, nest-site and mate fidelity, natal philopatry, and longevity. Scripps's Murrelets captured with a spotlight and dip-net were banded to assess population trends. Currently, banding effort has not continued long enough to generate adequate sample sizes for most analyses. We recommend increased and continued banding effort for these species to allow for further assessment of colony recruitment, population trends, and demography in the future.

## AN INTERESTING TERN OF EVENTS: LEARNING FROM CASPIAN TERNS AND OTHER SALMON-EATING WATERBIRDS ABOUT WHAT MATTERS MOST FOR COASTAL COLONIAL SEABIRDS

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Over the last 16 years we investigated factors that limit the size and productivity of coastal seabird colonies in the northeastern Pacific, colonies that prey on anadromous salmonids listed under the U.S. Endangered Species Act. While the primary motivation for these studies has been to design efficient, non-destructive means for reducing the impact of avian predators on recovery of listed salmonids, our research has provided a number of insights into the ecology and conservation of coastal seabirds throughout the Pacific Basin. First, availability of secure sites for breeding colonies is a key limiting factor for a community of coastal seabirds whose nesting habitat has been disturbed, degraded, or destroyed by anthropogenic change. As global sea-level rise proceeds, this trend will accelerate for many coastal seabirds that rely on low-lying coastal islands as colony sites, particularly ephemeral early successional habitats. Second, if you build it, they will come; restoration of declining populations of seabirds can, in

some cases, be as simple as constructing islands or other suitable nesting habitat and providing social cues that counteract the neophobia of colonial seabirds. Third, nesting habitat isn't everything; the location, size, and productivity of coastal seabird colonies reflects a complex and dynamic interplay of both the availability of suitable nesting habitat and the proximity of adequate forage. For example, Caspian Terns (*Hydroprogne caspia*) in western North America have shifted from nesting entirely at large inland water bodies to primarily coastal anthropogenic sites, including the world's largest Caspian Tern breeding colony at the Columbia River mouth. This shift can be ascribed to both a shift in available nesting habitat and higher, more consistent availability of forage fish in estuaries. Fourth, many coastal colonial seabirds are fugitives from predators that gradually key in on large, perennial aggregations of ground-nesting seabirds, causing seabird colonies to shift frequently among sites as a means of mitigating intense top-down effects from focused and efficient predators. Bald Eagles (*Haliaeetus leucocephalus*) and large gulls (*Larus* spp.) are especially likely to habitually visit coastal seabird colonies and synergistically cause large numbers of nests to fail, even causing total colony collapse. The lower levels of colony philopatry characteristic of coastal seabirds compared to oceanic seabirds are adaptive in avoiding such predator pits. Fifth, just in the last 40 years populations of a number of coastal colonial seabirds in western North America, including Caspian Terns and Double-crested Cormorants (*Phalacrocorax auritus*), have begun recovering from extensive persecution, over-harvest, and reproductive impairment from persistent organochlorine pesticides. Recovery has now proceeded sufficiently for some fisheries managers to label these and other piscivorous colonial waterbirds as "native invaders," and are seeking extensive exceptions to protections afforded these species by the Migratory Bird Treaty Act. Seabird ecologists, managers, and conservationists need to remind fisheries managers and stakeholders that increasing populations of coastal seabirds are recovering, not erupting. Finally, for some coastal colonial seabirds (e.g., Caspian Terns) effective long-term conservation will require on-going management in a metapopulation context to provide networks of suitable habitat for breeding birds to choose from.

#### PATTERNS OF AT-SEA ANTHROPOGENIC THREATS TO SEABIRDS IN THE NORTH PACIFIC: A COMPARISON OF LAYSAN ALBATROSS (*PHOEBASTRIA IMMUTABILIS*) AND SOOTY SHEARWATER (*PUFFINUS GRISEUS*)

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At-sea threats to seabirds have been largely under-characterized and their importance relative to land-based threats remains predominantly un-evaluated. As a first step to holistically assessing the distribution and importance of at-sea anthropogenic threats specific to seabirds, we created a spatially explicit map of for the North Pacific. Currently included are five categories of threats focused on pollutants: Organic pollution, Inorganic pollution, Shipping, and Marine Debris. The analysis will ultimately add six additional categories: Large Oil Spills, Bycatch, Fisheries Competition, Fisheries Ecosystem Disturbance, Sea Surface Temperature Change, and Wind Speed Change. Using information about the life-history, feeding habits and physiology of Laysan Albatross (*P. immutabilis*) and Sooty Shearwater (*P. griseus*), we scaled the threat maps according to differences in the vulnerability of the species to each threat. The resulting maps show minor disparities in the distribution of threats for the two species. Here, we present detailed maps and analysis of the patterns of threats, comparing the two species. We consider the results in the context of the ranges of Laysan Albatross and Sooty Shearwaters.



## COLLABORATIVE, INTEGRATED SCIENCE EXPEDITION TO THE ST. MATTHEW ISLANDS, ALASKA

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The St. Matthew Islands (St. Matthew, Hall, and Pinnacle) are part of the Alaska Maritime National Wildlife Refuge. These islands are widely considered the most remote wilderness in Alaska, and one of the most remote locations in the National Wildlife Refuge System. The Alaska Maritime National Wildlife Refuge has conducted intermittent ecological monitoring at the St. Matthew Islands since 1983. The objective of this long-term monitoring program is to collect baseline status and trend information for a suite of seabird species that serve as indicators of ecosystem health. Data also provide a basis for directing management and research actions, and in assessing effects of management. During late July and early August 2012, we visited Hall Island and St. Matthew Island. We counted ledge-nesting seabirds on long-term population monitoring plots. Due to broad interest in the region across a variety of disciplines, we invited an interdisciplinary team of scientists to accompany us to the island to carry out a wide suite of research and monitoring projects. Here we summarize the major field accomplishments for each of the projects, including a summary of historical counts of ledge nesting seabirds from Hall Island and detailed population and productivity information from 2012. The results from this diverse group of projects will help provide an integrated snapshot of biodiversity in an area that is particularly vulnerable to climate change. Similar interdisciplinary trips throughout the refuge will become more prevalent as a way to leverage opportunities as well as address ecosystem-scale questions.

## TEMPORAL VARIATION IN SEABIRD FORAGING WITH RESPECT TO PREY IN CATTLE PASS, SAN JUAN ISLAND, WA

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Published and unpublished reports suggest that seabird numbers, especially those of pursuit-diving seabirds, have decreased markedly in the Salish Sea over the past several decades. We tested the hypothesis that seabird feeding activity in Cattle Pass, San Juan Islands, Washington, decreased in 2011 and 2012 in comparison to the mid-1990s, and that this decrease was associated with a concomitant decrease in the abundance of small, pelagic fish (“forage fish”). Our data collection replicated methods used by Zamon during summers of the mid-1990s, including land-based surveys of multi-species seabird foraging aggregations, multi-frequency acoustic surveys to determine the distribution and abundance of forage fish, and vertical plankton tows. We found significant decreases in seabird foraging activity between decades, as well as a consistent decline in area integrated backscatter (a measure of forage fish abundance). Inter-annual variability in seabird foraging activity and forage fish abundance were generally correlated, suggesting that changes in seabird foraging activity was reflecting variation in the local availability of prey. To test for changes in the vertical distribution of forage fish, we analyzed the acoustic data from the top 30m and top 10m of the water column separately and found that backscatter from the top 10m was less variable between decades than that from the top 30m, although this is likely a result of conservative data processing. Analysis of the plankton data are ongoing, and will allow testing of the hypothesis that changes in forage fish abundance were related to changes in their prey community.

## COPULATION CALL AND BEHAVIOR OF GLAUCOUS-WINGED GULLS (*LARUS GLAUCESENS*)

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Copulation in gulls is accompanied by dramatic wing-flapping behavior and loud vocalizations. We recorded male copulation calls and documented the associated copulation behaviors for approximately 30 pairs of Glaucous-winged Gulls (*Larus glaucesens*) from 05:30–21:00 h for a 21-day period. Poisson distribution analysis indicated that copulatory mounts were not randomly distributed in time for the subarea of the colony occupied by these birds. Poisson regression analysis showed that number of mounts/h increased with the day of year and tide, and mounts/h decreased as time of day increased. Wind speed, solar elevation, barometric pressure, humidity, and occupancy were not significant indicators of mounts per hour. Logistic regression analysis indicated that every m/s increase in wind speed reduced the odds of mount resulting in cloacal contact by 8%; similarly, every 100 W/hour/m<sup>2</sup> increase in solar radiation reduced the odds of a cloacal contact by 11%. Mounts lasted an average of 87 sec, while the average duration of the copulation call was 48 sec. Male gulls express a distinctive copulation call with unique spectral and temporal features never before described. In our sample, each pulse of sound of the copulation call lasted an average of 156 ms with an average inter-pulse interval 205 ms. Pulse duration and interval were positively correlated. Calls were characterized by an average fundamental carrier frequency of 1001 kHz with multiple harmonics.

## SPATIAL ECOLOGY OF KRILL, MICRONEKTON AND TOP PREDATORS IN THE CENTRAL CALIFORNIA CURRENT: IMPLICATIONS FOR DEFINING ECOLOGICALLY IMPORTANT AREAS

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Marine spatial planning and ecosystem models that aim to predict and protect fisheries and wildlife benefit greatly from syntheses of empirical information on physical and biological partitioning of marine ecosystems. Here, we develop spatially-explicit oceanographic and ecological descriptions of the central California Current region. To partition this region, we integrate data from 20 years of shipboard surveys with satellite remote-sensing to characterize local seascapes of ecological significance, focusing on krill, other micronekton taxa, and top predators (seabirds and marine mammals). Specifically, we investigate if micronekton and predator assemblages co-vary spatially with mesoscale oceanographic conditions. The first principal component of environmental and micronekton seascapes indicates significant coupling between physics, primary productivity, and secondary and tertiary marine consumers. Subsequent principal components indicate latitudinal variability in niche-community space due to varying habitat characteristics between Monterey Bay (deep submarine canyon system) and the Gulf of the Farallones (extensive continental shelf), even though both of these sub-regions are located downstream from upwelling centers. Overall, we identified 5 ecologically important areas based on spatial integration of environmental and biotic features. These areas, characterized by proximity to upwelling centers, shallow pycnoclines, and high chlorophyll-*a* and krill concentrations, are potential areas of elevated trophic focusing for specific epipelagic and mesopelagic communities. This synthesis will benefit ecosystem-based management approaches for the central California Current, a region long-impacted by anthropogenic factors.

## RADAR STUDIES OF INLAND ACTIVITY PATTERNS OF THE MARBLED MURRELET ACROSS THE ANNUAL CYCLE IN NORTHERN CALIFORNIA

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The Marbled Murrelet (*Brachyramphus marmoratus*) is a species of conservation interest throughout its range and particularly in the Pacific Northwest where it is listed as a Threatened species under the federal Endangered Species Act. Past research on inland activity of this seabird that nests in large trees has focused on the peak period of breeding activity and therefore much less is known about possible inland flights of murrelets during the spring and fall transitional periods and also during the winter period. We used dual marine radars to study inland activity patterns and flight altitudes of murrelets at three sites (Crescent City, Espa Lagoon, Eel River) in northern California across the entire annual cycle in 2012. We selected sites based on historical surveys that showed high activity levels at these sites. We completed a total of 89 morning radar surveys across 9 different survey periods from February–December 2012. As anticipated, peak levels of murrelet activity occurred during the June–July period at all sites; however, we detected murrelets during all survey periods, including the winter months. Inland flights of murrelets in the spring increased in early- to mid-April and in the fall numbers dropped during early- to mid-August. We recorded the lowest levels of murrelet activity during the September–October molting period and the winter months. Results of this study fill a critical information gap on seasonal patterns of murrelet activity at inland sites and will be useful to federal and state agencies making land use decisions that impact murrelets.

## PRELIMINARY RESULTS OF AN EXPERIMENTAL STUDY OF GEOLOCATION TAG-EFFECTS ON PARAKEET AUKLETS

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Auklets are the numerically dominant seabirds breeding in Alaska, but little is known about their behaviour outside of their short breeding season. Winter movement and behaviour at sea are often cited as key missing pieces of information when evaluating effects of natural and anthropogenic factors on auklet populations. Of the auklets, Parakeet auklets (*Aethia psittacula*) are believed to disperse the most widely, and are among the least well studied of the auklets in terms of breeding biology. We deployed 19 geolocation tracking tags on adults breeding on Buldir Island, Alaska in 2012 to test the feasibility of the project and assess the effects of tags on breeding success. We found no difference in chick growth or fledging success between nests of tagged adults and controls. Chick growth rates across all treatments were greater than measurements from Buldir in 1991, possibly indicating a year of abundant food resources. Fledging success was also above average for Buldir. When tags are recovered next summer we will continue to experimentally measure effects of tags on survival, condition and reproduction to ensure the biological relevance of tracking data. Preliminary results suggest that geolocation tags can be a valuable tool in the study of this species with little effect on the short-term well-being of study individuals. Future work will focus on long-term effects, and on determining wintering movements and habitat use in comparison with other auklets to inform future research and management decisions by identifying areas of vulnerability and characteristics of critical wintering habitat at sea.

## QUANTIFYING MISIDENTIFICATION RATES OF BRACHYRAMPHUS MURRELETS DURING AT-SEA ABUNDANCE SURVEYS

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Conservation of solitary nesting seabirds is challenging, most notably due to the technical difficulties associated with at-sea population abundance monitoring and their inaccessibility during the non-breeding season. These challenges may lead to unreliable trend, abundance, and biological data, hindering the implementation of effective management decisions. The Kittlitz's murrelet (*Brachyramphus brevirostris*) is a prime example for illustrating the difficulties of wildlife population monitoring. Due to their solitary and cryptic nesting strategies, Kittlitz's murrelet populations are most reliably monitored using boat-based surveys. However, due to the highly dynamic nature of the marine environment, these surveys can result in imprecise abundance and trend estimates. Survey efforts are additionally complicated by the overlap in range of the sympatric and morphologically similar congener, the marbled murrelet (*B. marmoratus*). Distinguishing between the two species is challenging, even under ideal conditions, which has led to varying rates of birds only identified to the genus level during surveys. Another consequence of their similar morphology is the potential for misidentification of individuals during at-sea surveys, which could have major implications for the resulting abundance and trend estimates. To address this issue, we are examining questions to clarify existing trend data for the Kittlitz's murrelet across its range by conducting formal field trials that will quantify the rates of species misidentification during surveys and the relative impacts of survey conditions on positive identification.

## THE INFLUENCE OF AGE, BREEDING STATUS, AND ENVIRONMENTAL VARIABILITY ON SURVIVAL OF BRANDT'S CORMORANT (*PHALACROCORAX PENICILLATUS*) ON SOUTHEAST FARALLON ISLAND

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Over the last 5 years (2008-2012), the success of breeding attempts by Brandt's Cormorant (*Phalacrocorax penicillatus*) on the Farallon Islands, California, has been unusually low (an average of 0.26 chicks fledged per pair). The numbers of individuals attempting to breed has also declined dramatically, falling from nearly 20,000 breeding individuals in 2007 to just over 3000 in 2012. Collectively, these have been the worst 5 years on record since monitoring of this colony began in 1971. The Farallones have historically hosted the largest colony of Brandt's Cormorant in the world. Thus, the low success and the precipitous drop in numbers of breeding birds are alarming. This has focused attention on the need to understand the factors driving variability in key demographic parameters for this species. Determining the age related variation in survival and breeding probability are essential steps in building the age-structured population model necessary for understanding the population consequences of the last 5 years. We used multi-state mark-recapture models to investigate patterns of age-related and environmentally driven variability in survival. Our results indicate survival varied substantially over time and with environmental covariates. Young birds do not begin returning to the colony until age 2 thus first year survival was indistinguishable from second year survival. Individuals of age 0-2 had the lowest apparent annual survival, while older (age 4+) individuals had the highest annual survival. Survival of breeders and non-breeders did not differ. The probability of breeding varied with age as well as with ocean conditions.

## LIVING AT THE EDGE: COMMON MURRES AT CASTLE ROCK NATIONAL WILDLIFE REFUGE

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The time allocation of chick-rearing murres over six years (2006-2011) was quantified to assess the relationship between co-attendance, chick provisioning, kleptoparasitism, and fledging success at Castle Rock. In a changing environment, Common Murres (*Uria aalge*) adjust their time allocation to maintain chick provisioning rates sufficient for chick survival and, consequently, have relatively high reproductive success. Breeding pairs spend substantial amounts of time together (co-attendance) at the colony when prey is abundant but co-attendance is reduced in order to provide adequate food to young when prey becomes scarce. At Castle Rock, co-attendance occurred during  $2.7 \pm 0.5\%$  of daylight hours, and chicks were left unattended during  $6.3 \pm 4.0\%$  of daylight hours. Intraspecific kleptoparasitism occurred frequently at this colony, with murres attempting to steal 18% of prey delivered to the colony by conspecifics in 2009. Percent of time spent in co-attendance was positively correlated with chick provisioning rates and was negatively correlated with the occurrence of successful kleptoparasitism. Chicks that fledged were fed  $0.28 \pm 0.01$  times per hour, which was 2.6 times greater than sites where chicks perished ( $P=0.007$ ). Additionally,  $4.1 \pm 1.1\%$  of prey was stolen from sites that fledged chicks whereas  $28.6 \pm 18.4\%$  of prey was stolen from sites where chicks died. Relative to other murre colonies, co-attendance at Castle Rock was extremely low. The time allocation of murres at Castle Rock suggests that chick-rearing individuals have maximized their efforts to adequately provision chicks; consequently, they may lack the capacity to further compensate for reductions in energy availability.

## SEABIRDS AS INDICATORS: PUFFIN DIETS LEND INSIGHT INTO ELUSIVE FORAGE FISH

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Forage fish, including fishes and zooplankton that are preyed upon by larger predators, are integral to marine ecosystems because of their abundance, dense aggregations, and nutritional content. Much of our information about Alaskan forage fish, however, is inferred from non-targeted surveys. Tufted Puffin (*Fratercula cirrhata*) deliver various prey items to their burrows during the chick rearing season, and chick diets may provide an index of the relative abundance and community-structure of local fish. To further explore this hypothesis, we sampled puffin chick diets from 10 islands from the central and eastern Aleutian Islands, Alaska, August 13-22, 2012. We screened >2000 puffin burrows, waited for adults to provision their chicks, then collected and identified prey. We also measured and weighed chicks to assess body condition. We collected 356 chick meals composed of 3,641 individuals and at least 31 forage fish species. The relatively nutrient-poor walleye pollock (*Theragra chalcogramma*) dominated chick diets survey-wide, representing 76% of individual prey items and 67% of total biomass. We measured 168 chicks, and investigated the relationship between chick condition and prey biomass. Using seabirds as indicators of forage fish allows insight into both elusive fish communities and the correlation between food and seabird recruitment.



## DESIGNING A SEABIRD OBSERVATION PROTOCOL FOR THE SEA EDUCATION ASSOCIATION

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The Sea Education Association (SEA) is dedicated to marine exploration, understanding, stewardship, and the study of humanity's relationship with the oceans. SEA offers high school and undergraduate students an interdisciplinary curriculum, with on shore and at sea components aboard oceanographic sailing school vessels. Cruises are primarily conducted in the tropical and subtropical eastern Pacific Ocean, the northwestern Atlantic Ocean, and the Caribbean Sea. Studies of seabirds on these cruises have been limited in the past, primarily due to constraints of identification for inexperienced students, especially in tropical – subtropical areas of generally low bird abundance. We wish to augment these past efforts by developing standardized survey protocols and identification guides that will allow students to collect meaningful distributional data. Visiting scientists have also participated in some of our past cruises, providing opportunities to collect traditional transect survey data while introducing motivated students to topics in seabird biology and conservation. Our primary goals are to: (1) determine what level of taxonomic identification and ancillary data are both required by researchers and feasible for students, and (2) design a protocol that will enable the collection of survey data valuable for collaborative projects. Another goal of this presentation is to explore whether members of the Pacific Seabird Group research community are interested in joining future SEA cruises.

## CONSERVATION OF THE MARBLED MURRELET AND THE PACIFIC SEABIRD GROUP: HOW IT STARTED

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Since 1986, the Pacific Seabird Group (PSG) has been well respected as a global leader for Marbled Murrelet (*Brachyramphus marmoratus*) conservation. PSG efforts began before Portland Audubon petitioned to list the Marbled Murrelet in Washington, Oregon and California in 1987. In 1986, Seattle Audubon contacted Leschner (then PSG chair) to confirm that murrelets were threatened in Washington. Leschner contacted Carter and Sealy, the only biologists then focused on murrelets, who had identified impacts from mortality in gill nets and loss of old-growth forests in British Columbia in 1979-1982. They had given key presentations at 1982 and 1984 PSG meetings and at the 1982 International Council for Bird Preservation (ICBP) World Conference. ICBP recognized the Marbled Murrelet as a species of concern in 1982 and the Alaska PSG representative submitted a resolution for "Consideration of Marbled Murrelets in old-growth forest management", adopted in December 1982. At the PSG meeting in December 1986, Leschner convened an informal workshop to discuss murrelet conservation needs. Nelson had been monitoring old-growth forest birds in Oregon and had heard murrelets flying overhead at dawn (key for identifying and protecting breeding areas). Speich and Carter had examined murrelet distribution at sea (key for future monitoring), as well as seabird impacts from oil spills, another key conservation problem. At the PSG meeting in December 1987, the Marbled Murrelet Technical Committee was formed and the first Marbled Murrelet symposium was held. In 1988, a pioneering interagency/industry murrelet workshop in Portland also was held.

## EFFECTS OF INTER-ANNUAL VARIABILITY IN THE TRANSITION ZONE CHLOROPHYLL FRONT ON THE HABITAT USE AND REPRODUCTIVE SUCCESS OF LAYSAN AND BLACK-FOOTED ALBATROSSES

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The Transition Zone Chlorophyll Front (TZCF) is an important oceanographic feature of pelagic seabirds in the North Pacific. Laysan (*Phoebastria immutabilis*) and black-footed (*P. nigripes*) albatrosses breeding in the Northwest Hawaiian Islands show marked differences in usage of the TZCF, where Laysan albatrosses forage in more northwesterly waters and black-footed albatrosses foraging along the southern edge. The TZCF can shift latitudinally by more than 1000 km in a given season and we hypothesize that breeding success is impacted. Trends in reproductive success of these two species were assessed in relation to inter-annual variability in the location of the TZCF (0.2 mg m<sup>-3</sup> & 18°C sea surface temperature isopleth). Since 2003, foraging movements of both albatross species that breed on Tern Island, were studied during the chick-brooding period (January-February of each year) when adults are most time constrained, to determine the effect of TZCF location on albatross habitat use. Concomitantly, we examined colony-wide breeding success from 1983-2012. There was a significant negative correlation ( $r = -0.4$ ,  $p = 0.03$ ) between breeding success and distance to the TZCF and a positive trend ( $r = 0.5$ ,  $p < 0.001$ ) between bird travel distance and location of the TZCF for Laysan albatrosses only. There was also a positive temporal trend ( $R^2 = 0.32$ ,  $p = 0.05$ ) with minimum distance of the TZCF across years suggesting a gradual northward migration of the TZCF, consistent with predicted climate models. If real, southerly-breeding colonies of North Pacific albatrosses could be negatively impacted by changing ocean climate.

## PARALYTIC SHELLFISH POISONING KILLS KITTLITZ'S MURRELET NESTLINGS

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Paralytic shellfish poisoning (PSP) in humans is caused by eating shellfish contaminated with a suite of neurotoxins (saxitoxins) produced by marine dinoflagellates, most commonly *Alexandrium* sp.. Saxitoxin binds to and blocks sodium channels in nerve cell membranes, stopping the flow of nerve impulses; severe cases may result in respiratory paralysis that is fatal if untreated. PSP is well documented in humans, but has been rarely reported in wild birds. Shellfish accumulate saxitoxin through direct ingestion of toxic algae. Zooplankton also ingest toxic algae, and in turn may be ingested by marine organisms at higher trophic levels. The majority of documented bird deaths from PSP appear due to consumption of planktivorous fish. During 2011 and 2012, several apparently healthy Kittlitz's murrelet (*Brachyramphus brevirostris*) nestlings on Kodiak Island died. Most of these nestlings were being monitored by remote cameras. Nestlings were being fed regularly by adults and died during mild weather

conditions. High levels of saxitoxin were documented in crop content and/or liver in 87% of nestling carcasses (ELISA), and it was determined that exposure to saxitoxin was likely the cause of death. Camera data indicated that nestlings died shortly after consuming sand lance (*Ammodytes hexapterous*), which is the fish species most commonly associated with the biomagnification of saxitoxin. Marine bird deaths from PSP may be under-reported.

#### ACTIVE-SPECIFIC METABOLIC RATE AND ENERGY BUDGET DURING FORAGING TRIP IN STREAKED SHEARWATER CALONECTRIS LEUCOMELAS

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Energy costs play a role in determining seabird at-sea foraging strategies, but the extent to which individuals are able to adjust energy costs according to allocation decisions is poorly studied. We investigated the relationship between foraging behavior and energy cost and acquisition of chick-rearing Streaked Shearwater (*Calonectris leucomelas*), at Awa Island in Japan Sea between 2010 and 2012. Resting metabolic rates (RMR) in air and on water for Streaked Shearwater were measured for 24-hour by using open-flow respirometry. We also quantified time-activity budget using acceleration logger and simultaneously measured field metabolic rates (FMR) of shearwaters using doubly labeled water method. Their RMR averaged 229% higher on water ( $0.0683 \text{ kJ g}^{-1} \text{ h}^{-1} \pm 0.0082 \text{ s.d.}$ ;  $n=5$ ) than in air ( $0.0207 \text{ kJ g}^{-1} \text{ h}^{-1} \pm 0.0011 \text{ s.d.}$ ;  $n=10$ ). Five shearwaters attached acceleration logger spent  $37.0 \pm 12.3\%$ ,  $53.4 \pm 20.0\%$  and  $9.6 \pm 8.6\%$  of their time in flight, on water and on ground, respectively. Mean FMR of the shearwaters was  $0.0922 \text{ kJ g}^{-1} \text{ h}^{-1} (\pm 0.0180 \text{ s.d.}; n=5)$ . Based on %time on water, the flight cost was estimated to be  $0.145 \text{ kJ g}^{-1} \text{ h}^{-1}$ , which is high compared to the energetic cost of resting on water. Other sixteen shearwaters (male:  $n=10$ , female:  $n=6$ ) were fitted wet/dry activity loggers and examined their body mass change and %time on water during a foraging trip. The body mass changes during a foraging trip in males were significantly negatively correlated to %time on water, while those in females were significantly positively correlated. This suggests male and female shearwaters face different energetic constraints during foraging.

#### FINE SCALE FORAGING BEHAVIOR OF THE FREE-RANGING RAZORBILL

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Central place foragers, such as seabirds, commute between land-based colonies and widely dispersed foraging areas at sea, on an hourly to weekly basis. These foraging trips allow birds to replenish their bodily reserves and gather food for their offspring, but can also be energetically expensive: as birds travel further away from the colony, they need to fly longer, which results in increased foraging costs. This is particularly critical for auks, which use an energetically expensive flapping flight. However, by traveling longer, birds may gain prey of higher energetic value, but evidence for such a trade-off is scarce. To address this question, we investigated the foraging patterns of the razorbill (*Alca torda*) at the Skomer Island colony, Wales, UK by using bird-borne GPS and TDR recorders during the breeding season in 2011 and 2012. We calculated index patch quality (IPQ) at each dive (driven from the relationship

between dive depth, bottom time and duration) as a proxy for energetic reward, and studied its variation with travel distance and dive characteristics within and among dive bouts. We show that travel distance increased with IPQ and birds dove more frequently with higher IPQ. IPQ of returning birds that go back out foraging again during chick-rearing was higher than IPQ of returning birds that go back to the colony, suggesting birds extend foraging when higher quality patches were found. Our results suggest that higher energetic investments in foraging actually pay off in the case of razorbills as they capture prey with higher energetic value.

## MAPPING IMPORTANT AREAS FOR SEABIRDS: HOW TO DRAW THE BOUNDARY LINE

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During a multi-year process of identifying Important Bird Areas in Alaska we established new methods for recognizing globally significant seabird hotspots using data from pelagic survey transects. The process required developing gradient maps summarizing bird density or abundance by species, and a method for delineating boundaries. Drawing lines is necessary to establish conservation areas or perform marine spatial planning, yet few have focused on analytical approaches for moving from gradient maps to boundaries. We explored many spatial-ecological questions to find the most effective approach. Delineation methods included expert-drawn lines, buffering significant colonies, quantile maps, and density-dependent contours. We settled on a moving window approach to summarize data and derive boundaries because it required fewer processing steps, provided a measure of local abundance which allowed us to easily test significance thresholds, and is not sensitive to scaling issues related to study area size. The approach worked well for a wide range of birds, including loons, albatrosses, shearwaters, storm-petrels, cormorants, diving ducks, gulls, terns, and alcids in marine areas ranging from temperate to polar. These methods should be broadly applicable across ecosystem types and species guilds, including both short- and long-range foragers, and locally common to widely abundant species.

## MARINE IMPORTANT BIRD AREAS IN ALASKA

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Effective marine bird conservation requires knowledge of places necessary for nesting, foraging, and migration. Using an extensive colony database, and over 30 years of at-sea survey data, we developed a standardized and data-driven spatial method for identifying marine Important Bird Areas in Alaska waters. We classified globally significant areas in two categories: nesting colonies and pelagic foraging areas that hold more than 1% of the population of a species. Our analysis included the identification of “meta-colonies” to group multiple nearby nesting sites, and using marine ecoregions to indicate which overlapping pelagic areas should be combined into single Important Bird Areas for multiple species. The resulting 123 sites spanned 20 degrees of latitude and 56 degrees of longitude, in two different oceans, with climates ranging from temperate to polar, for 49 out of 58 assessed species. Colony Important Bird Areas included 26 million birds, capturing 89% of the colonial birds in Alaska using 15% of the mapped colonies. Pelagic Important Bird Areas included 19 million birds, capturing 38% of Alaska’s foraging seabirds within only 6% of the area. These methods were designed to be globally applicable across ecosystem types and species guilds, as well as adaptable to other types of input data. We built the final steps into geoprocessing tools to automate site identification, and from the results we developed a web-based mapping interface to encourage exploration of these important places.

## HOW MANY SEABIRDS DO WE NEED TO TRACK TO DEFINE HOME-RANGE AREA?

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In recent years marine predator and seabird tracking studies have become ever more popular. However, they are often conducted without first considering how many individuals should be tracked and for how long they should be tracked in order to make reliable predictions of a population's home-range area. As tracking studies are increasingly being used to aid the designation of marine conservation zones and to predict important foraging areas we suggest that many studies may be underestimating the size of these foraging areas and that better estimates could be made by considering both the duration and number of data logger deployments. Analysis was conducted on three seabird tracking datasets of 18 European shag *Phalacrocorax aristotelis*, 14 Black-legged kittiwake *Rissa tridactyla* and 16 Brown Boobies *Sula Leucogaster*. Our analysis suggests that these sample sizes predicted 20%, 18% and 40% of the areas of active use of shags, kittiwakes and boobies respectively. Also using just the first foraging trip in analysis underestimated the size of the foraging area compared to the area predictions made when four foraging trips were included in the sample. We propose that researchers intending to draw conclusions from tracking data should conduct a similar analysis of their data to determine the reliability of their home-range predictions.

## A BIOGEOGRAPHICAL ANALYSIS OF EXTIRPATION AND ENDANGERMENT ON SEABIRD BREEDING ISLANDS

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While seabirds play important functional roles in marine and terrestrial ecosystems, 28% of species are at risk of extinction. The most significant threats occur on breeding islands where proven conservation actions can protect seabirds. We identified, for the first time, all past and current breeding islands for the 98 threatened seabird species (IUCN - Critically Endangered, Endangered and Vulnerable) and the presence or absence of invasive vertebrates on each of these islands. We found 853 islands with data on the status of breeding seabirds since 1990. 1,074 seabird populations currently breed on 777 of these islands (some islands contained more than one threatened seabird species); while an additional 93 populations had been extirpated from 88 islands (some islands have both extirpated and extant threatened seabird populations). 91% of threatened seabird species, and 34% of all threatened seabird populations, bred on an island with at least one invasive vertebrate that is a documented threat to that seabird. Rodents were the most common invasive threat (46%) followed by cats (13%). Rats and cats can be successfully removed from islands. Based on an analysis of >800 successful insular invasive vertebrate eradications, 60% of the islands we identified are suitable for eradications using current technology. Because invasive vertebrates are a major driver of seabird breeding colony extirpations, this systematic analysis of global distribution and site-level threats will guide on-the-ground conservation actions with effective outcomes.



## CHASING ICE: POST-BREEDING BLACK GUILLEMOTS PURSUE RETREATING ICE INTO THE ARCTIC BASIN

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As one of few seabirds that both breeds and winters in the Arctic, Black Guillemots in the western Arctic (*Cepphus grylle mandti*) have limited migrations. Breeding from the Bering Strait north, they are known to winter as far north as Point Barrow, Alaska, and south to the ice edge in the Bering Sea. The lack of a defined migration and a close association with sea ice throughout the year is apparently due to the subspecies persisting in a refugium north of the Bering Land Bridge during the Last Glacial Maximum. In 2011, we deployed geolocators on six Black Guillemots breeding on Cooper Island, Alaska, retrieving five in 2012. Preliminary analysis of post-breeding movements shows that guillemots spend up to a week in open water off Point Barrow before undertaking a major movement north to the pack ice over the Arctic Basin, which in late September is at its furthest north retreat. In the 1970s, Black Guillemots occupied the ice edge relatively close to the coast, but we found birds were now flying as far as 800 km to find their preferred sea ice habitat. As extent of summer sea ice is predicted to decrease, the magnitude of post-breeding movements of Black Guillemots will continue to increase, with increasing energetic costs. Monitoring guillemot movements during this period of rapidly decreasing annual ice extent, and the predicted eventual disappearance of pack ice, would provide a valuable biological metric of the physical loss of arctic ice and its dramatic impact on pagophilic species.

## FILLING THE VOID: USING SUPER HIGH-DEFINITION VIDEOGRAPHY TO GATHER BROAD-SCALE BASELINE DATA ON MARINE WILDLIFE

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Marine spatial planning requires an in-depth knowledge of baseline conditions at a regional scale, including high quality information on the distribution and abundance of wildlife species and their use of marine habitats and other features. Developed in Europe, aerial surveillance employing high-definition video cameras has become an accepted, cost-effective method for broad-scale environmental and wildlife surveys and for detailed monitoring of the effects of development. Multiple video cameras mounted on the underside of twin-engine aircraft capture extremely high-resolution images ( $\leq 2$  cm ground spatial distance) which are examined and reviewed onscreen by experienced biologists, and targets identified to the lowest taxonomic group. Each video frame is geo-referenced with GPS, and parallax technology allows for the estimation of flight height of avian targets. Compared with traditional direct observational aerial surveys, the advantages of this innovative technique are many, including: increased accuracy, less bias, faster coverage, reduced disturbance, improved quality control, auditable data, and safer flying at higher elevations. This method also allows the assessment of multiple taxa (seabirds, marine mammals, etc.) in a single survey platform. In March 2012, we initiated the first broad-scale use of this technique in North America to survey seabirds, marine mammals, and sea turtles in the offshore waters of the mid-Atlantic region on the eastern seaboard. Here, we highlight the accuracy and advantages of this survey method, the ease of identification of different taxonomic groups, and the challenges faced. We provide recommendations on the application of this technique in marine spatial planning moving forward.

## MARINE MICRO-HABITAT SELECTION BY FLEDGLING AND OLDER MARBLED MURRELETS IN OREGON AND NORTHERN CALIFORNIA COASTAL WATERS: WHERE ARE THE KIDS?

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Pertinent to the reliability of productivity indices is the differential distribution of the age groups. Existing age ratio data suggest inadequate recruitment to maintain populations of Marbled Murrelets (*Brachyramphus marmoratus*) along much of the west coast. I analyzed the timing of concentrations of fledgling and after-hatch-year (ahy) birds along 220 Km of coastline in Marbled Murrelet Conservation Zone 4 (Coos Bay, OR to Shelter Cove, CA) during nesting and fledging periods using 12 years of vessel survey data. There was evidence of distribution shifts between nesting and late fledging/ molting periods for both age groups. Certain microhabitats had persistent concentrations of ahy birds after July. Fledgling murrelet concentrations correlated with those of ahy birds, but their locations were not so persistent. Sampling surveys intended to estimate productivity should quantify habitat types in their design, and attempt to sample by habitat as well as spatiotemporally.

## POST-FLEDGING SURVIVAL, BEHAVIOR, AND MIGRATION OF HAND- VS. NATURALLY-REARED SHORT-TAILED ALBATROSSES

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During 2008 to 2012 a nestling translocation and hand-rearing project was conducted to expedite the establishment of a third breeding colony in Japan for the endangered Short-tailed Albatross (*Phoebastria albatrus*). An important concern, however, was whether translocated and hand-reared fledglings would survive, migrate, and locate key foraging grounds similar to naturally-reared fledglings. Therefore, we applied an experimental approach during each year to compare post-fledging survival, behavior, and migration of translocated and hand-reared fledglings on Mukojima to a control group of naturally-reared fledglings at the source colony on Torishima. We attached 22 g solar Argos GPS satellite transmitters to an equal subsample of hand- and naturally-reared birds (n = 31 total per group, 5-7 per year each). After leaving the colony, fledglings typically “drifted” ( $\leq 5$  km/hr over 2-4 hr period) at sea for 9 days on average (range = 2 – 21 days) with only short flights before obtaining sustained flight. There was no significant difference in days to sustained flight between male hand-reared vs. naturally-reared fledglings, however, female hand-reared fledglings took significantly longer to reach sustained flight (mean = 12 days, sd = 3) than naturally-reared fledglings (mean = 8 days, sd = 4). Post-fledging survivorship to sustained flight averaged 85% overall and was not significantly different between hand- and naturally-reared chicks. All suspected post-fledging mortalities prior to sustained flight, however, were female birds. Both groups had comparable migration patterns, despite some variation in distribution. Overall, the hand-rearing process appeared to have little impact on post-fledging success.

## CASPIAN TERN INVASION OF ALASKA? NORTHWARD BREEDING RANGE EXPANSION OF THE PACIFIC COAST POPULATION

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Since the initial, 1983 sightings of Caspian terns (*Hydroprogne caspia*) in south-central Alaska, the numbers of adults and juveniles observed in Alaska have steadily increased. In 2005, two colonies were discovered on islands in the Copper River Delta, south-central Alaska and in Icy Bay, southeast Alaska. Both colonies grew rapidly and by 2012 reached 338 and 317 breeding pairs at the Copper River Delta and Icy Bay colonies, respectively. Based on re-sightings of color-banded adults, we documented (1) immigration from East Sand Island in the Columbia River estuary, the largest known breeding colony in the world, to the Copper River Delta and Icy Bay colonies; (2) immigration from a colony in San Francisco Bay to the Copper River Delta colony, longest known breeding dispersal for the species (approximately 3,000 km straight-line distance); and (3) inter-colony movements between the Copper River Delta and Icy Bay colonies. Management efforts to reduce the size of the East Sand Island colony to one-third its original size to mitigate the impact on recovery of ESA-listed salmonids would displace approximately 6,000 breeding pairs. Consequently, more tern immigration to colonies in Alaska from East Sand Island is expected. Long-term sustainability of the colonies in Alaska, however, is questionable. Flooding is evidently a limiting factor for the Copper River Delta colony, at least in some years, and wet, cold weather apparently caused the Icy Bay colony to fail in 2012. Climate change may have unexpected effects on recently-formed Caspian tern colonies in Alaska.

## FACTORS INFLUENCING EGG SIZE OF RHINOCEROS AUKLETS IN TEURI ISLAND, JAPAN

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Various factors such as female body condition, body size, type of prey during egg-production, and states of the mate (e.g., attractiveness) can affect variation in egg volume of seabirds. In addition, stable isotope (SI) studies have revealed recently that the diet during pre-egg-laying period is likely to affect egg volume. Rhinoceros auklet (*Cerorhinca monocerata*) is a piscivorous seabird, but feed on krill as well in the pre-egg-laying period. To examine the factors affecting egg volume of Rhinoceros auklet, we measured egg volume, female body size, body condition and SI of feathers (proxy of prey trophic level during molting) and blood (those during spring), as well as mate for three years (2010-2012). Further, in other nests, we measured those data and SI of egg yolk, albumen and membrane for two years (2011 and 2012). Both female body condition and male body size positively affect egg volume, but female body size and trophic level did not. SI of feather and blood of females did not correlate with those of egg yolk, albumen, and membrane: indicating that females used food resources for egg production that might be different from those eaten during molting of breast feather and spring. Female Rhinoceros auklet might invest more nutrition into the egg when they accumulated larger body store and mated more attractive male.

## STATUS OF JAPANESE MURRELETS (*SYNTHLIBORAMPHUS WUMIZUSUME*) AND RATS (*RATTUS* SP.) AT KOYASHIMA AND OKINOSHIMA, JAPAN

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Over the last 25 years, a small population of Japanese Murrelets (*Synthliboramphus wumizusume*) at Koyashima in Fukuoka Prefecture, Japan, has been nearly extirpated by Norway Rats (*Rattus norvegicus*). Koyashima (1.8 ha; 29 m) and adjacent Okinoshima (69 ha; 243.6 m) are 55 km off Kyushu in Tsushima Strait. Murrelet breeding has been known at Koyashima since 1933, but not previously at Okinoshima. In 1987, about 400 adult murrelets were killed at Koyashima by accidentally introduced Norway Rats; all rats at Koyashima were killed. In 2009, four murrelet carcasses were found at Koyashima and one Norway Rat was trapped and killed. At Okinoshima, only Black Rats (*Rattus rattus*) were found from 1958 to 1991. Norway Rats were first found at the port in 1992. In 2010 and 2012, we set small mammal traps from the port to the peak at Okinoshima. Norway Rats were distributed widely from the port area to higher-elevation natural forested habitats, whereas Black Rats and House Mice (*Mus musculus*) were restricted to the port. In 2012, we conducted spotlight surveys in at-sea congregations around these islands to document current population levels at Koyashima and to search for undiscovered breeding areas at Okinoshima. Small numbers of murrelets were found at sea around Koyashima and around the remote north side of Okinoshima with steep coastal habitats that are inaccessible to rats. Future plans include eradication of rats and mice from Okinoshima to prevent extirpation and allow recovery of murrelets at both Koyashima and Okinoshima.

## ASSESSMENT OF THE EFFECTS OF ANTHROPOGENIC IMPULSIVE SOUND ON THE MARBLED MURRELET IN THE MARINE ENVIRONMENT

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While at-sea, marbled murrelets (*Brachyramphus marmoratus*) may encounter impulsive sound from anthropogenic activities in both the underwater and in-air environments. Underwater impulsive sound is known to impact a wide variety of vertebrate species and in-air sound is known to mask bird vocalizations. In Puget Sound and along the outer coast of Washington State, sources of impulsive sound include marine construction and military training activities. To assess the potential effect of murrelet exposure to impulsive sound we developed an analytical framework that relies on thresholds for both injury and behavioral effects. Both the analysis approach and the effect thresholds were developed by USFWS staff with input from expert panels and multi-disciplinary working groups. The newly established threshold for onset of physical injury is a cumulative sound exposure level of 202 decibels (re: 1 micropascal). Revision of the behavioral effects analysis is in progress and considers how murrelets may respond to impulsive sound heard both underwater and in-air. These thresholds inform Endangered Species Act consultations and influence monitoring requirements in the field. The overall exposure/response analysis includes calculations of areas of effect, probability estimates of exposure, and application of conservation measures.

## PLASTICS IN THE PACIFIC: REGIONAL COMPARISONS OF MARINE PLASTIC INGESTION BY NORTHERN FULMARS

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Plastic pollution is increasingly recognized as an escalating threat to marine ecosystems. In the face of this developing issue, monitoring ocean-wide levels of pollution has become crucial. Successful monitoring programs utilizing Northern Fulmars (*Fulmarus glacialis*) as bioindicators of marine plastic pollution have been instituted in northern Europe and central California. As generalist and surface feeders, fulmars are an ideal indicator due to their susceptibility to ingesting plastic debris. In this study, we examined fulmars from northern Oregon and southern Washington (n=89) to determine the frequency of occurrence, abundance, size and color of plastic ingested and make inferences about the state of marine plastic pollution in the Pacific Northwest and feeding habits of fulmars. We compared these findings with those of birds from Alaska (n=46) and California (n=44) to obtain information on regional differences in plastic pollution in the northeastern Pacific. Levels of plastic ingestion differed as a function of region. California and Washington birds ingested significantly more pieces of plastic ( $\bar{x}$ =17.5 and 13 respectively) than Alaskan birds ( $\bar{x}$ =4.3,  $p<0.001$ ). California and Washington birds also ingested a significantly greater mass of plastic ( $\bar{x}$ =551.5 mg, and  $\bar{x}$ =376.9 mg, respectively) than Alaskan birds ( $\bar{x}$ =52.4 mg,  $p=0.01$ ). While results suggest marine plastic densities vary regionally, in all regions plastic ingestion was prevalent.

## THE USE OF CONSPECIFICS AS CUES TO LOCATE FOOD IN A SEABIRD FORAGING TRIP

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Foraging seabirds use behavioral strategies specifically adapted to the dynamic prey distribution in the marine environment. These preys are aggregated in patches that move constantly in space, in addition to be difficult to locate from the surface. In this environment, colonially breeding seabirds cope with specific constraints as *central place foragers*. The distance between their breeding location and their foraging zones forces them to regularly loose contact with prey in order to come back to the colony and feed their chick. Thus, every foraging trip becomes a paper chase in which seabirds have to use indirect cues to locate prey efficiently. The use of other predators by means of an information transfer on the location of food is the main hypothesis that has been proposed to deal with this challenge. Several mechanisms of prey detection have been suggested in the literature, such as the *local enhancement* or the *information center hypothesis*. We deployed GPS and cameras on Cape Gannets (*Morus capensis*) breeding at Bird Island (Nelson Mandela Bay, South Africa) in December 2010. Video footage provided accurate information on the behavior of the study animals so we quantified different behavioral phases along the trajectories of 35 birds. Moreover, the direct observation of the seabirds' surroundings informed about their interactions with conspecifics. We identified foraging cues used by the Cape Gannets to locate prey and measured the distances of detection/reaction towards these cues on their trajectories. We show how these distances vary with the number of predators aggregated on a patch.



## INVESTIGATIONS ON WINTER CARRYOVER EFFECTS AND ONSET OF BREEDING IN RHINOCEROS AUKLETS (*CERORHINCA MONOCERATA*)

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Considerable progresses in tracking seabirds at sea over prolonged periods provide now invaluable insights in population dynamics to understand how steps are linked throughout the annual cycle. In this study we compared how migrating and breeding chronology of Rhinoceros auklets (*Cerorhinca monocerata*) from Teuri Island, Sea of Japan, varied between one "normal" year (2010-2011) and the following one (2011-2012) characterized by poorer sea-surface productivity on the wintering areas and deeper snow cover in spring. Using light- and temperature-based geolocation technique, we collected 19 complete tracks over the two inter-breeding seasons. Innovative modeling approach enabled us to distinguish stop-over (wintering) from migration behaviors at sea, and activity data allowed inferring attendance patterns on the colony. Our results show that while average post-breeding departure dates (on 23 July) and wintering areas (mainly around Korean peninsula) were alike between the two years, the birds started their return migration 10 days later on average in 2012 compared to 2011. Accordingly, the first night attendance on the colony in March was also 8 days later on average in 2012. In addition, average duration of the pre-laying period was also longer of 8 days in 2012: this lead to a total shift measured of 16 days in the average incubation start date between the two years. These results suggest that pre-breeding conditions both at-sea (such as marine productivity) and on the colony (such as snow cover) may be cumulative in affecting breeding readiness in a migrating seabird, which will in turn impact fitness through breeding success.

Sarah K. Thomsen, A. Laurie Harvey, and Frank Gress- At end of abstracts  
SEABIRDS AND SHOREBIRDS OF SWAINS ISLAND, AMERICAN SAMOA

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Swains Island (11.0544 N, 171.0896 W) is an uninhabited 2.27 km<sup>2</sup> former copra plantation 360 km North of American Samoa. The coconut palm (*Cocos nucifera*) dominated island was last surveyed in 1976. The goal of this September 17-26 2012 survey was to identify the seabird and shorebird species present, relative abundance, distribution across the island, and potential threats. Two shoreline surveys were conducted on September 19 and 22 by walking the 6.2 km shoreline, identifying all birds within a 100 m by 50 m strip. Shoreline surveys recorded six shorebird and nine seabird species dominated by Black Noddy (*Anous minutus*, average = 905±136 SE birds/km<sup>2</sup>), White Tern (*Gygis alba*, average = 500±69 SE birds/km<sup>2</sup>), and Brown Noddy (*Anous stolidus*, average = 217±36 SE birds/km<sup>2</sup>). Additionally, nine random transects were surveyed from the shoreline, bisecting the forested habitat towards the central lagoon. Forest transects revealed four species roosting or breeding; Black Noddy (0.0016±0.0011 SE birds/m<sup>2</sup>), White Tern (0.0010±0.0004 SE birds/m<sup>2</sup>), Brown Noddy (0.0001±0.0001 SE birds/m<sup>2</sup>), and Red-footed Booby (*Sula sula*, 0.0001±0.0001 SE birds/m<sup>2</sup>). Seabird densities were significantly higher in the NW section of the island (ANOVA, F=5.675, df=2, 24, p=0.01), furthest from former settlements. All birds were observed roosting or nesting in trees and preferentially found in *Pisonia spp.* (62.7%) and *Pandanus spp.* (23.0%). Although pigs (*Sus scrofa*) were recently eradicated, Pacific Rat (*Rattus exulans*) was observed over all island sections, likely posing threats to seabird populations. Rat control and expansion of preferred nesting tree species would likely improve seabird populations.

## QUANTIFYING SEABIRD COLLISIONS WITH POWER LINES

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Power line collisions are a threat to birds worldwide with take estimates in the 100's of millions, yet techniques for quantifying collisions are constrained by the wide distribution and often inaccessibility of lines. On Kauai, power lines are considered a serious threat to the endangered Newell's Shearwater (*Puffinus newelli*) and the Hawaiian Petrel (*Pterodroma sandwichensis*). Our aim was to quantify collisions island-wide, which required developing multiple approaches to best suit the varied terrain and accessibility of lines. We took 3 main approaches: 1) basic searches under accessible lines combined with searcher efficiency and carcass removal rate trials, 2) development of a collision/passage model by overlapping a subset of ground searches with a study of seabird passages using ornithological radar, night vision and thermal optics, 3) the use of auditory recording devices to 'listen' for power line collisions in areas inaccessible to searchers. Twelve Newell's Shearwaters were located dead or injured under accessible lines. However, none were found during the collision to passage study despite 270 hours of observations and searches. We discuss the limitations to this approach. Observations in remote mountainous areas located lines particularly dangerous to seabirds, where 10 bird strikes were recorded in 11 nights. These collisions produced a distinct and repeatable sound detected by both observers and auditory recording devices. We developed geospatial maps to highlight areas most at risk for seabird collisions by combining the locations of downed birds and lines strikes with variation in power line and vegetation heights and changes in topography.

## STOCK-SPECIFIC PREDATION OF RHINOCEROS AUKLETS (*CERORHINCA MONOCERATA*) ON JUVENILE SALMON IN COASTAL BRITISH COLUMBIA

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Much of the mortality of Pacific salmon (*Oncorhynchus spp.*) is thought to occur during the first months following ocean entry due to predation. The timing of the seaward migration of pink, chum and sockeye salmon coincides with the chick provisioning period of rhinoceros auklets (*Cerorhinca monocerata*), which are known to feed on them. The vast majority of juvenile salmon from Southern and Central BC funnel past aggregations of breeding auklets totalling hundreds of thousands of individuals nesting at key points along migration pathways in Central and Northern BC. The component of juvenile salmon in provisioning diets ranges between 0-20%, representing 1-5 individuals. Sampling at 3 colonies in summer 2012, we observed previously unseen amounts of salmon, and many loads were exclusively salmon; 51% of which were sockeye, 31% pink and 18% chum salmon. DNA stock identification revealed a full 98% of sockeye originated from the Fraser River system at all colonies; for pink, southern colonies were dominated by Puget sound stocks (93-99%) and the northern colony was split between these and North coast stocks; for chum, colonies were split between Fraser, Puget and Vancouver Island stocks. There were pronounced differences between colonies in the specific stock composition suggesting important spatial-temporal patterns in migration. Sampling at bird colonies was concurrent with coast wide juvenile salmon trawl surveys. For all species, size and condition were significantly lower for predated salmon at each colony relative to respective survey salmon providing evidence for size-selective predation and suggesting a relationship between condition and predation susceptibility.

## THE ALBATROSS ABOUT OUR NECK: THE STATE OF THE OCEANS REVEALED THROUGH THE FAMILY DIOMEDEIDAE

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Despite the lesson of the Ancient Mariner, the albatrosses (family Diomedidae) have faced an onslaught of human threats including slaughter for food, sport, and vanity, fisheries interactions, chemical and plastic pollution and climate change as evidenced by 17 of 22 species recognized by IUCN listed as vulnerable, endangered, or critically endangered. As long-lived wanderers that are found throughout the Pacific and Southern Oceans, albatrosses may serve as sentinels for a large portion of the oceans. This presentation will focus on geographical (generally greater in the North Pacific) and temporal (generally increasing) trends of plastic and chemical pollution reported in the literature and from recent work with Laysan Albatross (*Phoebastria immutabilis*). The albatrosses still have many a tale to tell, that may make us rise sadder and wiser.

## FORAGING STRATEGIES AND POST BREEDING DISTRIBUTION OF THE HAWAIIAN PETREL (*PTERODROMA SANDWICHENSIS*), FROM THE ISLAND OF LĀNA'I.

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Understanding the distributional patterns of a species as well as behaviors associated with these patterns is important for identifying habitat range and potential threats therein. We used geolocators (GLS tags) to describe the at-sea distribution and foraging behavior of the endangered Hawaiian Petrel (*Pterodroma sandwichensis*) from the island of Lāna'i. Positions were collected during late chick rearing and through the post-breeding season. During chick rearing our results confirmed a bimodal foraging strategy, with individuals alternating between short (1-5 days) trips, proximate to the Hawaiian Islands, and long trips (10-17 days) clockwise around the North Pacific (n=11). We found a significant difference in daily distance traveled between these short and longer duration foraging trips, with daily travel significantly further on longer trips. Differences in the foraging behavior were examined via the salt water immersion and transition logs. Interestingly, we found no difference in the daily percentage of time spent on the water or the number of landings on the water. Reduced energy expenditure during long foraging trips may occur in flight, with birds using favorable wind conditions to lower cost of searching more productive northern latitudes. Although our sample size is small (n = 2 individuals), this study is the first to document Hawaiian Petrel movements and foraging activity through the post-breeding season. Both individuals left the main Hawaiian Islands and headed south east where their tracks predominantly wandered westward, north of the equator, following along the Pacific North Equatorial Current (PNEC), before returning to the breeding colony for the season.

## RISKS TO TOP-LEVEL PREDATORS REVEAL COMMUNITY-LEVEL CHANGE IN A MARINE ECOSYSTEM

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Monitoring community-level changes across large marine ecosystems is central to proper management and conservation of these systems. This is a sizeable challenge, particularly in ecosystems transcending international borders where governance structures can be poorly coordinated for effective monitoring and subsequent management. By analyzing long-term monitoring data with epidemiological tools we identified commonalities in life history traits among declining species within a community of upper-level predators – the wintering marine bird community of the Salish Sea, a 17,000 square kilometer transboundary marine ecosystem in the Pacific North West of North America. To do so, we first integrated and analyzed marine bird winter census data from several long-term monitoring programs across the Salish Sea. We then identified species-specific risk factors that increased the likelihood of species within foraging guilds to be exhibiting declining trends during the last 20 years. We found that species at the highest risk of experiencing declines belonged to two foraging guilds: pursuit divers specializing on forage fish and benthic foraging seaducks who mainly eat mussels and clams. Our findings provide evidence that diving birds with specialized diets such as common murre (*Uria aalge*), western grebes (*Aechmophorus occidentalis*), and scoters (*Melanitta sp.*) are becoming a smaller proportion of winter marine bird community in the Salish Sea, likely as result of changing availability of their low-trophic level prey. Our epidemiological approach allowed us to identify important drivers of ecosystem change in the absence of complete data on low-trophic level prey. Future challenges in ecosystem-based management of large marine ecosystems will likely be related to resource limitation amongst the low-trophic level prey of upper-level predators.

## DAYTIME OCCURRENCE OF DEAD MESOPELAGIC FISH AND SQUID AT THE SEA SURFACE AND THEIR IMPORTANCE AS A PREVIOUSLY UNRECOGNIZED FOOD RESOURCE FOR OCEANIC MARINE BIRDS

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The presence of mesopelagic fish and cephalopods, most of which do not normally occur alive at the surface during any time of day, in the diets of many marine bird species has been the source of considerable controversy. Typically, ingestion of mesopelagic species, particularly cephalopods, is interpreted as evidence of a nocturnal feeding strategy. Recent telemetry and diet studies of Laysan albatross in the eastern North Pacific reveal that diurnal scavenging on dead mesopelagic cephalopods may be their primary natural feeding strategy. However, until now, evidence of dead squid in the surface waters in sufficient numbers to support such a feeding strategy was largely absent. In 2006, during ongoing small-vessel odontocete surveys in Hawai'i by Cascadia Research Collective, we began noting the presence of seabirds feeding on dead floating cephalopods and fish. Since then we have collected 104 specimens and obtained an additional 20 specimens from other individuals working on the water (8 fish, 116 cephalopods). More than half the specimens were collected in association with scavenging seabirds

(seven species of Procellariiformes), and 13 specimens were associated with or in the general proximity of odontocete cetaceans (five species). Species composition was diverse, 20 species of cephalopods and 8 fish species were represented. The cephalopods represented were mostly adult stages and the species composition resembles that reported from Laysan and Black-footed albatross chick regurgitation pellets collected from several breeding sites in the Hawaiian Leeward Islands.

#### WINTERING AREA OF STREAKED SHEARWATERS AND MERCURY IN THEIR TAIL-FEATHERS: OCEANIC SCALE MONITORING OF POLLUTANTS

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Pollutants (heavy metal and POPs) released in the environment are bio-magnified through the food chain and some of these impacts the health of marine organisms. For marine planning, the distribution of these toxic chemicals needs to be monitored. Finding heavily polluted areas over the oceans, however, is difficult or requires large cost. Feathers of seabirds are easily sampled and so have been used as indicators of heavy metal pollution. We propose here a tool for monitoring large-scale spatial pattern of marine pollution using the movements and the tissue samples of seabirds. We tracked year-round movement of Streaked Shearwaters *Calonectris leucomelas* breeding on three islands in Japan and measured mercury in their outermost tail-feather (R6) and breast-feather. Individual birds spend 3-4 month non-breeding season in each of South China Sea (SCS), Arafura Sea (AFS) between New Guinea and Australia, or the sea north of New Guinea (NNG). Mercury in the tail-feather that replaced during non-breeding season was higher for SCS (3.1 ppm) than AFS and NNG birds (0.8 ~ 1.5 ppm), while those in the breast-feather that replaced during later breeding season as well did not show significant spatial patterns. Nitrogen stable isotope ratio, a proxy of trophic level, of the tail-feather was related to the mercury contents weakly and positively overall but was not different between birds wintering in the different areas. These indicate that SCS was more polluted with mercury than AFS and NNG. Thus our study demonstrates the usefulness of seabirds for oceanic scale monitoring of pollutants.

#### RECENT ADVANCES IN PROTECTING THE SEABIRD FORAGE BASE IN THE SOUTHERN CALIFORNIA CURRENT

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Newly established marine protected areas and fisheries management policies in the U.S. west coast have improved conservation of food resources required by seabirds and other wildlife. Commercial and recreational fishing constituents were included in planning processes and provided support at key junctures. In California, a network of coastal marine protected areas protect portions of state waters from some or all extractive uses, and prevent human disturbance at some important seabird colonies. Also in California, a new state policy establishes the intent to prevent new fisheries from developing on forage species, and prevent the expansion of existing fisheries for forage species. In Oregon, new state marine reserves and adjacent protected areas were recently established through state legislation. In Washington,



Oregon and California, new federal policies establish the intent to prevent new fisheries from developing on forage species, and provide better mechanisms for including predator needs in existing fisheries plans for forage species. Collectively, these new regulations and policies acknowledge and highlight the critical ecosystem role played by forage species, and will increase the availability of forage for locally-breeding and visiting seabirds and other marine wildlife. These advances complement substantial financial and human investment in the restoration of seabird islands here and across the Pacific, and may serve as an example for other state and nations for advancing marine reserves and fisheries policies to support forage species conservation.

## STABLE ISOTOPE AND DIETARY ANALYSES REVEAL THE ROLE OF A CRYPTIC PREY IN THE ELEGANT TERN FOOD WEB IN SOUTHERN CALIFORNIA WATERS

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The species composition of dropped fish collected at Elegant Tern (*Thalasseus elegans*) colonies in southern California has shifted from being dominated by northern anchovy (*Engraulis mordax*) in the 1990s to >60% kelp pipefish (*Syngnathus californiensis*) by 2011. This observation was unexpected as ELTE is an open-water forager, and pipefish are cryptic in a kelp habitat. During the 2012 nesting season at Los Angeles Harbor, we examined the degree to which pipefish have become incorporated into the ELTE food web and therefore by how much this tern may be part of both pelagic and benthic food chains given the differing habitats of two main prey species. We are using for our analysis dietary and  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values of ELTE, northern anchovy, kelp pipefish, particulate organic matter, and giant kelp (*Macrocystis pyrifera*), as well as ELTE  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values for 1999 as reference when virtually no pipefish were delivered. Direct observations in 2012 revealed that the ELTE chick diet comprised 8% kelp pipefish and 61% northern anchovy; however, dropped fish still comprised a high proportion of pipefish. The isotope analyses, currently in process, are expected to show that anchovy and pipefish are both incorporated into ELTE tissues, though pipefish not as prominently as we initially expected. Both fish should occur on approximately the same trophic level, but are members of pelagic and benthic food chains, respectively. This study will provide information on an under-studied but abundant, cryptic fish species and its role in the food web of a seabird predator.

## FEATHER CORTICOSTERONE AS AN INTEGRATIVE MEASURE OF NUTRITIONAL STRESS IN SEABIRDS: A 3 COLONY COMPARISON OF RHINOCEROS AUKLET CHICKS

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Food availability has been shown to be a major factor determining survival and reproductive success of seabirds. Seabird chicks raised under nutritional constraints show poor morphological development and long-lasting effects on their quality. Currently tools available for measuring nutritional stress in seabird chicks, such as sampling blood, provide only a “snap shot” of the physiological stress the individual is currently experiencing. We validated a new endocrinological technique of measuring the stress hormone corticosterone in the feathers of fledgling rhinoceros auklets (*Cerorhinca monocerata*). This technique provides an integrated measure of circulating corticosterone for the duration of the feather’s growth. We found that levels of corticosterone in a fledgling’s feathers reflected those measured in weekly blood samples: chicks raised on a restricted diet (50% of ad libitum) exhibited higher levels of corticosterone in their feathers compared to controls. We then applied our feather corticosterone technique to determine

whether nestlings experienced differences in nutritional stress under variable environmental conditions. We sampled wild fledglings at St. Lazaria and Middleton Island (Alaska) and Teuri Island (Japan). In 2012 these three colonies had contrasting patterns in reproductive phenology suggestive of differences in food supply. Herein we discuss results of our analysis of differences in fledgling stress among these three colonies and the appropriate application of this novel technique in seabird monitoring programs

#### COMPARISON OF GILLNET FISHERY EFFORT AND MARBLED MURRELET (BRACHYRAMPHUS MARMORATUS) POPULATION TREND DATA IN THE SALISH SEA

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Marbled murrelet monitoring has revealed a recent decline in population trends in Washington State. From 2001-2010, the number of wintering birds in the Salish Sea for Puget Sound and the Strait of Juan de Fuca has declined by 7.4% per year. In contrast, offshore drift gillnet and nearshore set gillnet fishery efforts have shown an average increase of 20% over the same time period. Marbled murrelet mortality from gillnet fisheries was identified as a threat in the 2009 U.S. Fish and Wildlife 5-Year Review. For several years, Washington State has implemented gear modifications, night and morning change of light closures, and fishing area closures to reduce bird mortality. Minimal bird entanglement monitoring is conducted. In 2012, NOAA began a collaborative spatial modeling effort with USFWS and the Forest Service to overlay murrelet population density data with fisheries catch effort data. The objective of this project is to identify overlap of high density areas of marbled murrelets and fishery effort, closely examining area and seasonal timing of both birds and fisheries. Preliminary analysis shows catch for Washington State has decreased over the last ten years in areas with past high fishery catch rates corresponding with a high presence of marbled murrelets. However, in areas with past low fishery catch rates and low incidences of marbled murrelet, fishery efforts have increased. When completed, this project will assist Federal agencies in identifying high risk areas to be considered in future fishery consultations to reduce the potential for marbled murrelet fishery mortality.

#### COMBINING MARINE BIRD DENSITY SURFACE MODELS USING SPATIAL CONSERVATION PRIORITIZATION SOFTWARE TO AID SITING OF OFFSHORE DEVELOPMENT

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A substantial increase in the number of proposed offshore wind energy developments (OWED) in the United States, particularly along the Atlantic Coast, has increased interest in the distribution and abundance of marine birds in southern New England. We conducted aerial line-transect surveys from 2010-2012 throughout a 3,800 km<sup>2</sup> study area off the coast of Rhode Island for the Ocean Special Area Management Plan (SAMP). We developed density surface models (DSMs) of bird populations which accounted for imperfect detection and incorporated spatially-explicit environmental covariates (remotely sensed chlorophyll *a*, water depth, sediment size, bottom roughness, distance from coast, latitude and longitude). We then used Zonation, a spatial conservation prioritization software package, to combine these marine bird DSMs to identify OWED sites that could potentially minimize negative impacts to marine bird populations. The DSM approach when combined with Zonation provides a relatively simple, multi-species spatial prioritization solution for marine spatial planning that could be used for future siting of OWED.

## MARBLED MURRELET PROTECTION UNDER THE ENDANGERED SPECIES ACT

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The history of Marbled Murrelet (*Brachyramphus marmoratus*) listing and habitat protection provides a window into the requirements and particularities of the Endangered Species Act. The U.S. Fish and Wildlife Service (FWS) protected Marbled Murrelets in Washington, Oregon, and California as a threatened species under the Endangered Species Act in 1992. FWS designated over 3.8 million acres of federal, state, and private land as murrelet critical habitat in 1996 and issued a final recovery plan in 1997. Prompted by timber industry litigation, FWS completed two five-year status reviews in 2004 and 2009; FWS denied a petition to delist Marbled Murrelets filed by timber interests in 2010. Protecting Marbled Murrelets under the Endangered Species Act for two decades has been complicated by several factors, including the fact that the species crosses the international border with Canada. FWS gave the tri-state portion of the Marbled Murrelet population protection as a “distinct population segment” and a “significant portion of the species’ range,” both terms which have legal—as opposed to biological—definitions. These legal terms do not always mesh seamlessly with the best scientific information on the murrelet’s status. Current ongoing litigation to remove Endangered Species Act protections from the tristate population of Marbled Murrelets ignores evidence of the population’s continued decline, especially at its southern end in central California. At the same time, FWS’s agreement to vacate designated critical habitat conflicts with recent murrelet monitoring that has shown a strong, positive correlation between population size and amount of suitable nesting habitat.

## HOTSPOTS IN COLD SEAS: THE COMPOSITION AND DISTRIBUTION OF SEABIRDS IN THE NORTH AMERICAN ARCTIC.

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Climate change is rapidly altering the distribution and extent of Arctic sea ice, thereby affecting Arctic marine ecosystems. At a time of increasing pressures on these ecosystems from industrial development, climate change and pollutants, a better understanding of the spatial-temporal abundance of seabirds is critical for conservation and sound management strategies. However, relatively little is known about the marine distribution of Canadian Arctic avifauna during the breeding season. To address this knowledge gap, we conducted seabird surveys in July and August, 2007-2012 with transits through the Northwest Passage between Victoria, BC and St. John’s, NL. We examined the distribution of seabirds in Arctic waters off the coasts of Canada and the United States and identified marine hotspots. Thick-billed Murre (*Uria lomvia*), Northern Fulmar (*Fulmarus glacialis*), Dovekie (*Alle alle*), and Crested Auklet (*Aethia cristatella*) were the most abundant species throughout the study period. Kernel density analysis by foraging guilds identified several annually-persistent marine hotspots; these include Davis Strait, parts of Lancaster Sound, and waters between Unimak Pass and northern Bering Strait, AK. Hotspots were related to proximity to colonies, sea ice extent and areas of heightened productivity. In marked contrast to the hotspots, the region between King William Island and Dolphin and Union Straits, NU supported very few birds. A better understanding of the underlying oceanographic processes that perpetuate annual seabird hotspots is essential for current conservation strategies and for predicting the impacts of climate change on Arctic ecosystems and the seabirds that depend upon them.

## MOVEMENT OF SHORT-TAILED SHEARWATERS WITH ENVIRONMENTAL GRADIENT IN THE SUB-ARCTIC PACIFIC AND ARCTIC SEAS THROUGH SUMMER TO AUTUMN

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Short-tailed shearwaters *Puffinus tenuirostris* are one of the most numerous seabirds and feed on key prey species including krill, fish and squids. The shearwaters breed in Australia in October –March and migrate to the North Pacific and spend non-breeding season there in April-September. Basing on boat survey they appear to range all over northern North Pacific. Recently it is known that some of them get into the Arctic Sea, though their seasonal movement pattern has been little known. To examine how their movement patterns relate to seasonal marine environments, we tracked those breeding on Great Dog Island, Tasmania, during 2009/2010 (n = 19) and 2010/2011 (n = 24) using geolocators. Individual birds showed three different patterns of habitat use. Nine stayed in the northwestern Pacific-Okhotsk Sea (WEST), 15 stayed in the southeastern Bering Sea (EAST), and 19 stayed in the northwestern Pacific-Okhotsk Sea during the summer and moved into the Bering Sea in September (WEST TO EAST). Eight of EAST and 13 of WEST TO EAST moved into the southern Chukchi Sea in September. Northward movement appeared to coincide with the seasonal increase in sea surface temperature (SST) within these regions. Twelve out of 19 birds (63%) moved into Arctic Sea in 2010 while only 9 out of 24 birds (38%) did in 2011 when SST in southeastern Bering Sea during September was lower. This is probably because their major prey, i.e. krill, becomes less available as warm surface water is likely to inhibit surface swarming.

## CASUES AND CONSEQUENCES OF MATE CHOICE PLASTICITY: IS SAME-SEX PAIRING IN LAYSAN ALBATROSS MAKING THE ‘BEST OF A BAD JOB’?

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Same-sex pairing is rare but known in many species, suggesting this behavior may be a plastic and potentially adaptive response to variable demographic and environmental conditions. We examined how the high frequency of unrelated female-female pairs (29%) in Laysan albatross (*Phoebastria immutabilis*) affected mate choice plasticity and fitness. We used multi-state mark-recapture models to compare survival and demographic transitions between females in female-female pairs vs. male-female pairs. Females in successful same-sex pairs skipped the next breeding season more often than those in successful male-female pairs, suggesting a higher reproductive cost for female pairs. The probability of transitioning to the opposite pair type was low in successful male-female pairs and failed female pairs, but higher in failed male-female pairs and successful female pairs. Because female pairs also had lower annual reproductive success, these results suggest males assess female quality and choose mates based on reproductive performance, thereby exerting sexual selection and potentially forcing low quality females into same sex pairs. These results support the hypothesis that plasticity in mate choice under varying demographic conditions, such as a skewed sex ratio, may allow a population to exploit and adapt to varied ecological and evolutionary opportunities.

## RED FLAGS OR RED HERRINGS? USING SEABIRDS IN A SUITE OF ECOSYSTEM INDICATORS TO DETECT ANOMALOUS CONDITIONS IN THE GULF OF ALASKA IN 2011

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Several lines of evidence from ecosystem indicators ranging from physical to upper trophic suggest that there were anomalous conditions in the Gulf of Alaska during 2011 and that these conditions were influenced by bottom-up forcing. Widespread seabird reproductive failures and increased prevalence of nutrient-deficient (“mushy”) Pacific halibut (*Hippoglossus stenolepis*) during summer were early indicators that foraging conditions for upper trophic-level predators were poor that year. Abundance indices of plankton and forage fish; halibut stomach contents; and ocean surface currents further indicated that anomalous conditions occurred. In this study we describe (1) the suite of indicators that the National Oceanic and Atmospheric Administration monitors for early signals of ecosystem change that may have management implications, (2) how seabird indicators play a role, (3) and their importance in providing early detection of ecosystem change. We compare multiple lines of evidence that suggest that changes in bottom-up forcing factors negatively influenced productivity at the lower trophic level that in turn negatively influenced upper trophic organisms. We note that the first indications were observed in upper trophic organisms (forage fish eating seabirds and Pacific halibut), emphasizing the utility and importance of seabird indicators to informing managers, scientists, and the public about ecosystem state.

## FLIGHT HEIGHT AND STYLE OF SEABIRDS IN RESPONSE TO WIND SPEED AND DIRECTION

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We summarized data on the flight behavior of seabirds obtained on 131,354 sightings of 271 species tallied during 87 cruises that spanned much of the Pacific Basin 1976-2006, with effort concentrated in the California Current, Peru Current, tropical/subtropical waters (including Hawaii), waters around New Zealand, and the Southern Ocean. Our interest was to determine how high seabirds fly, an attribute relevant to anticipating potential impacts of coastal wind farms, and also the wind speeds at which seabirds in the 25 (29 after additions) flight groups of Spear & Ainley (1997, Ibis 139:234-251) transitioned from flapping to flap/gliding to gliding flight as well as changing flight height. We studied potential new groupings based on flight height and behavior. The transitions in flight behavior, expanding the study of Pennycuik (2002, Avian Science 2:1-12) for 9 species, are important to understanding seabird energetics, the energy of the wind being as important for many species as that obtained from food. We accounted for differences in flight height and behavior by relative flight direction (i.e., head winds, cross winds and tail winds) as well as location. We also examined the probability of flying at particular flight heights or undertaking certain flight behaviors relative to wind speed, using cumulative logit and continuation-ratio logit models.



## DAILY SURVIVAL RATE OF NESTS OF WILSON'S PLOVERS IN SOUTH CAROLINA

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Wilson's Plovers (*Charadrius wilsonia*) are beach-nesting birds that often nest with or adjacent to colonies of terns or American Oystercatchers in the southeastern USA. Threats to beach-nesting birds in this region include anthropogenic habitat modification and disturbance, sea-level rise, and predation from native and non-native species. Little is known about the reproductive ecology of Wilson's Plover in the southeastern USA. We studied nest success at two field sites, South Island and Sand Island, at the Tom Yawkey Wildlife Center in South Carolina. During the 2012 breeding season we monitored 39 nests over 103 days. A total of 17 nests hatched and 22 nests failed. The primary causes of failure were flooding and predation although abandonment and failure due to unknown causes also occurred. The average initiation date was 29 April 2012, the average hatch date was 18 May 2012, and the average failure date was 16 May 2012. The daily survival rate (DSR) of nests at South Island was 0.9748 and at Sand Island was 0.9652. The probability of success over a 25 day incubation period at South Island was 0.5289 and at Sand Island was 0.4124. We also measured DSR of nests within three habitat types. DSR was 0.9644 in immature dune, 0.9747 on the strand, and 0.9674 in the dune field. The probability of success was 0.4041 in the immature dune, 0.5275 on the strand, and 0.5236 in the dune field. Nest success appeared to be affected by location which left low lying nests at risk of flooding.

## WINTER MARBLED MURRELET (*BRACHYRAMPHUS MAMORATUS*) CALLING IN NON-FORESTED HABITATS OF WOMENS BAY, ALASKA.

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Year-round attendance by Marbled Murrelets (*Brachyramphus marmoratus*) in forested nesting habitat has been observed in many areas south of Alaska, and this behavior is speculated to be related to courtship, pair-bond maintenance, nest prospecting, and territoriality. This study describes the winter attendance of Marbled Murrelets at an unforested, high-latitude site (Womens Bay, Kodiak Island). Marbled Murrelet calls were recorded over 39 days between Dec 9, 2011 and April 22, 2012. Murrelet calls were heard 53 to 23 min before sunrise with the peak daily occurring ~40 min pre-dawn. The number of individual daily detections ranged from 1-47 with an average of 2 and median of 8 detections respectively per recording day. Total amount of call activity recorded varied daily ranging from 5 seconds to nearly 6 minutes averaging almost 3 minutes per recording day. More detections (N=337) were recorded on days warmer than winter minimum average temperatures ( $>-2.2^{\circ}\text{C}$ ) however, the total daily length of calling activity recorded during those days was <34 min (31%) of the 107 min of total recordings. High wind or severe weather conditions precluded any recording efforts. Calling appeared to occur primarily inland from the coast, with all detections focused landward of the recording station (3 km from sea). Thus, the likely purpose of vocalizations was in intraspecific communication at or near potential nesting habitat rather than during commuting flight. Consistent calling activity by murrelets throughout a particularly severe winter (record snowfall and temperature range  $-19^{\circ}\text{C}$  to  $5.6^{\circ}\text{C}$ ) illustrates the importance of this behavior.

## LIVING ON THE EDGE: SPATIOTEMPORAL PATTERNS OF BARN OWL PREDATION ON SCRIPPS'S MURRELETS ON SANTA BARBARA ISLAND

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Over half the world's breeding population of Scripps's Murrelets (*Synthliboramphus scrippsi*) nests 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 habitat use of Barn Owls. Specifically, study objectives were to 1) describe habitat use of Barn Owls (with line transects and telemetry); 2) describe rodent prey availability in various habitats (with track tubes) and 3) determine the contribution of seabirds in owl diet by collecting pellets and prey remains. We summarize results from two consecutive years with highly contrasting prey conditions; one year with relatively high mouse density followed by a year with much lower mouse density. Track tube indices consistently showed greater mouse activity in murrelet nesting areas than habitats in the interior of the island, and Barn Owls were also more frequently detected on line transects adjacent to murrelet habitat. This pattern of space use persisted regardless of the availability of seabirds as prey. However, there were substantial differences in the number of murrelets killed by owls. In 2011, when mouse densities were high, few murrelets were killed, while in 2012 predation on murrelets was much more severe. These results are consistent with the alternative prey hypothesis. Continued research will help determine the impact on murrelet population dynamics.

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