†Two Species of Oceanic Birds that Lay Single-Egg Clutches Do Not Adjust Yolk Androgens to Environmental Conditions

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It is widely believed that female birds strategically allocate androgens to yolk in the manner that best equips offspring for feeding conditions during their development. Because most avian studies have focused on multi-egg clutch species, and interpreted results within the framework of sibling competition, we still know little about how yolk androgens might be allocated in direct response to environmental conditions. Most oceanic birds are long-lived and lay single-egg clutches, and their breeding success is tightly linked to highly variable marine production. That combination: a variable breeding environment, long lives, and single-egg clutches, make oceanic birds good subjects to test hypotheses about yolk androgen allocation strategies. We measured concentrations of two yolk androgens, androstenedione (A4) and testosterone (T), in the single-egg clutches laid by early-laying Cassin’s (Ptychoramphus aleuticus) and rhinoceros (Cerorhinca monocerata) auklets at Triangle Island, British Columbia, Canada, in 2002-2004. Environmental conditions varied over those three years, and in response, both the timing and success of breeding varied. As in other avian species, concentrations of A4 and T varied markedly among individual eggs in both species (by factors of 3 to 8), yet contrary to expectation, little of the variation could be attributed to year effects. The high interindividual variation and the lack of interannual variation suggest a non-adaptive explanation for yolk androgen deposition in these species.

†Does Developmental Strategy Effect Yolk Antibody Allocation? A Test in the Alcidae

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The immune system at hatching is relatively undeveloped, and young are vulnerable to parasite and pathogen infection. Female birds deposit antibodies into their eggs, and the embryo takes these up into circulation during the final days of incubation. Maternal antibodies remain in circulation for the first few weeks of life. These antibodies serve as passive immune defense against infection. They are widely believed to be beneficial, by preventing the diversion of resources away from growth for immune response. However, the costs of yolk antibody allocation remain unknown. The nutritional cost of antibody production for eggs is negligible, and yet antibodies account for only about 0.1% of the total protein deposited in the egg. One hypothesized cost is the interference of immune development in the chick due to diminished antigen exposure. Thus, in species where specific immune responses are important very early in life, the developmental cost of maternal antibodies will be high, because immune responses will be diminished. Whereas in species where time to immune maturity may be longer, and specific immune responses less important in early life, the cost of maternal antibodies will be low, because the development of specific immune responses is delayed beyond the time period of passive immunity conferred by maternal antibodies. We predict that developmental strategies on the precocial end of the spectrum will select for reduced yolk antibody allocation, compared to the altricial end of the spectrum. We test this hypothesis in the Alcidae, a family with a diversity of developmental strategies.
Double-Crested Cormorants on the Columbia Plateau: A New Focus for Management?

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Recent observations indicate that the Double-crested Cormorant (Phalacrocorax auritus) population on the Columbia Plateau in Washington State is growing in both the number of breeding pairs and number of colonies. For example, the colony at Foundation Island on the Columbia River has grown from approximately 100 breeding pairs in 1998 to over 300 pairs in 2007 and the colony on the Potholes Reservoir has nearly doubled in the last decade to over 1,000 pairs. Smaller colonies have also become established, and nesting attempts have been noted at new locations in recent years. Furthermore, there appears to be a substantial and increasing number of non-breeding cormorants in the region. These trends apparently reflect a general post-DDT era recovery of the Pacific Coast subspecies P. a. albociliatus. Nevertheless, salmon managers and local fishers have raised concern over the impact of cormorant predation on survival of salmonid smolts (Oncorhynchus spp.) from the Columbia and Snake rivers. While the proportion of salmonids in the diet of the Foundation Island cormorants (15-20%) is much less than that of Caspian Terns nesting nearby (61-69%), the numbers of smolt PIT tags recovered from the cormorant colony exceeded those recovered from the tern colony in 2007. Any management of Double-crested Cormorants on the Columbia Plateau to reduce smolt losses will require a status assessment of this population in the context of the entire Pacific Coast subspecies and a demonstration that cormorant predation on the Columbia Plateau negatively affects recovery of ESA-listed salmonid stocks.

Can Patterns of Energetic Condition Explain Differences in the Productivity of Arctic and Common Terns (Sterna paradiseae & S. hirundo) at Petit Manan Island, Maine?

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In the state of Maine, Arctic and Common Terns (Sterna paradiseae & S. hirundo) are listed as species of concern. For the past century the two species have responded differently to conservation efforts and the basis for these differences remains unclear. Identifying the physiological factors that limit the two species from full recovery is critical for the conservation of their populations. To better understand the basis for different responses in recovery between the two species, I compared the physiological condition of the birds throughout key periods of the breeding season. I examined the condition of the terns when they first arrived to the island, and throughout the incubation and chick rearing periods. The changes in physiological condition throughout the breeding seasons were examined within and between species.

An individual’s ability to meet their energetic demand is dependent on their physical condition upon arrival at the nesting colony, and influences their subsequent breeding success. To determine how well an individual is meeting their energy demands, I examined baseline corticosterone (energy-regulating steroid), plasma metabolites (indicators of the processes of putting on or using fat) and breeding hormones (indicators of reproductive state) and linked these with breeding success. Measurements of parental effort were monitored to document individual activity related to clutch productivity. Based on my preliminary data, Arctic Terns arrive at their colonies in a reduced condition and remained in poorer condition than Common Terns. The differences in fitness between the two species may explain the discrepancy in nesting success and population recovery.
Tern’ing to Video to Study Diet, Lateralization, and Chick Development among Bill Load Holding Birds

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Video recording behavior is a powerful means of documenting details that are impossible to perceive in the field in real time. Good video footage can also be extremely valuable in developing educational and training materials. We have collected video over the last 10 years during diet and reproductive studies of Caspian Terns (Hydroprogne caspia) in the Columbia River Estuary, Oregon and California Least Terns (Sterna antillarum browni) in San Diego, California. More than 20 species of fish have video documentation in the diet of Caspian Terns and at least 6 fish species are recorded for Least Terns. A DVD with video files and extensive stills has been organized for preseason training of the identification of bill loads in both terns and would likely be valuable for other species of waterbirds that hold fish in the beak crosswise. A detailed slow-motion analysis of catalogued video resulted in discovering lateralization in the feeding pattern of Caspian Tern adults and chicks. Lateralization is the term for asymmetries or biases in behavior associated with right or left orientations. In their first week of life Caspian Tern chicks had a preference for fish being delivered with the prey’s head oriented to the right of the parent’s bill. The pattern was strongest in elongate fish (e.g. engraulids) and not observed among ovate species (e.g. embiotocid perch).

Conservation Implications of Niche Separation between Surf and White-Winged Scoters in Northern Puget Sound

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While declines in many marine bird populations are well-documented, the role of specific habitat resources in such declines is often unknown. To guide protection efforts, we are evaluating habitat use patterns of Surf Scoters (Melanitta perspicillata) and White-winged Scoters (M. fusca) in bays of alternative benthic habitats in northern Puget Sound. Our analyses include new information on seasonal scoter abundance, diet, foraging behavior, condition, and prey availability. Our results indicate that the ability of White-winged Scoters to consume larger prey likely enables them to continue consuming bivalves and thus maintain condition and forego costly movements when smaller bivalves preferred by both species are depleted. Alternatively, Surf Scoters appear to have multiple strategies to partially compensate for seasonal declines in their condition. For instance, Surf vs. White-winged Scoters consume a greater diversity of prey, and as winter progresses often move to consume herring spawn or seasonally abundant epifauna in eelgrass habitat. Since the 1970s, numbers of White-winged Scoters have increased by 30% and Surf Scoters have declined by 45% in northern Puget Sound. Our results indicate that conservation strategies for Surf Scoters in particular may require protecting a complex of marine habitat resources with distinct seasonal values. However, further analyses are needed to clarify the relative importance to these unique population trends of changes in marine resources in this region vs. changes in migration and breeding areas.
Consequences of Colony Size in the Royal Tern (Thalasseus maximus): Egg Predation by Gulls on Isla El Rancho, Sinaloa, during the 2007 Breeding Season

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Allegedly, colonial nesting helps in preventing or reducing egg predation. Hence, colony size might be important in such an effect. During the breeding season of 2007, we studied two colonies of Royal Tern (Thalasseus maximus) of different size, 1,400 and 300 nests, on Isla El Rancho, Sinaloa, in the middle portion of the Gulf of California, Mexico. We made four 1-week visits to the colony in April and May 2007. We monitored the colony, including nest contents, with binoculars 1-3 times/day/colony (mostly 2 times/day), twice a week, from two vantage points. We estimated nest density in 1-m sq every 2 m along a line transecting the colony in its center, and evaluated rate of egg predation by gulls in the middle and edge of each colony in both colonies by a two way Analysis of Variance. The large colony had a density of 9.88 nests/m² in the middle, and 8.79 nets/m² at the edge, whereas the small colony had densities of 8.25 and 5.4 nets/m², respectively. Removal of eggs by gulls occurred only at the periphery of the colonies, and most occurred during the morning. Egg removal was statistically higher in the small colony (0.54 eggs/hour throughout the study), than in the large colony (0.25 eggs/hour). Our data agrees with the idea that larger colonies offer more protection of eggs against predation.

One-Hundred Years of Population Change in the Glaucous-Winged Gulls of the Southern Gulf Islands

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Recent analyses of systematic counts of nesting Glaucous-winged gulls (Larus glaucescens) in the Southern Gulf Islands have suggested that the species is in decline, perhaps as a result of ecosystem-level prey depletion or increases in predators such as Bald Eagles (Haliaeetus leucocephalus) or River Otters (Lutra canadensis). A 2007 census of the largest breeding colony in the Georgia Basin (Mandarte Island) showed that this population has declined by 75% since 1985. Related censuses of Mandarte Island's south Islet and Imrie Islet show that the species no longer maintains breeding populations at these former colony locations. In this talk we consolidate available data on population trends of Glaucous-winged gulls in the Georgia Basin and for Mandarte Island over the last century. Our results reveal that systematic censuses by the Canadian Wildlife Service commenced at a peak in numbers during the mid-1980's, following roughly 40 years of near-geometric increase in breeding numbers. Sparse long-term records from Mandarte Island further reveal that the population rose from a low of approximately 400 pairs near the turn of the last century, to reach a high of roughly 3000 pairs in 1985. Contrary to earlier analyses, we suggest that the large gull populations of the 1980’s resulted from a relaxation of limits on reproductive success and/or juvenile survival as a consequence of unlimited access to refuse and other of human wastes. We further show that the current decline in gull numbers commenced in the mid-1980s and coincided with changes dump closures and other regional advances in human waste management. We discuss some indirect effects of primitive waste management on island ecosystems in the Georgia Basin, in particular the Garry Oak plant communities of Mandarte, Arbutus and Imrie Islands. In sum, our results point to the critical need for long-term monitoring programs to correctly interpret the causes of population change in seabirds and the appropriate responses of managers to apparent ecosystem change.


Population Assessment of Humboldt Penguin at the End of the 2004 Breeding Season in Peru

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The Humboldt Penguin population is distributed from Foca Island (Peru, 5º 12’) to Corral Corral (Chile, 39º 52’) and its nesting area from Punta Aguja (5º 47’) to Punihuil Island (41º 55’). Counting of the main Humboldt penguin colonies was performed between the 12º 18’ S and 17º 42’ S (center and south of Peru) during July and August 2004. Conversations were held with fishermen about their interactions with the Humboldt penguin. It was to collect information about the threats on this bird. A total of 3101 adult penguins were observed. Most of the penguins (83.2%) were found in islands and headlands with some degree of protection, those managed by PROABONOS (62% in 10 sites) and in the Paracas National Reserve (21% in 3 sites). The most important reproductive colonies in number for Humboldt penguin are Punta San Juan (38.2%), Pachacamac Island (11.4%), San Gallan Island (11.3%), Tres Puertas (9.5%) and San Juanito (8.7%). The censuses carried out in the last twenty years differ in the periods when they were done and the sites evaluated. However, the common thing is that Punta San Juan, Pachacamac Island and Tres Puertas Cave are still important colonies for Humboldt penguins for over twenty years. The threats observed during the study for the Humboldt Penguin were: incidental and directed capture, guano harvest, the use of explosives for fishing, tourism and mining pollutants.

Plastic Fantastic: Seabird and Marine Debris Interactions in the Eastern Tropical Pacific

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We collected data on seabirds and marine debris simultaneously during a cetacean and ecosystem assessment cruise in the oceanic eastern tropical Pacific during August – November of 2006 aboard two NOAA research vessels (240 sea days). The geographic area spanned waters from the US-Mexico border south to Peru and west to Hawaii, including approximately 21 million km² of water and the Exclusive Economic Zones of 12 nations. Standard 300 m strip transect methods were used for each data set. Seabirds were identified, counted, and behavior recorded. Marine debris was identified (using 10 categories: organic, plastic, wood, monofilament, glass, rubber, metal, Styrofoam, paper/cloth, other), and individual items were counted. As expected, density of marine debris varied spatially and was highest in shelf and nearshore waters of most countries, and convergence zones such as the Equatorial Front. Plastic items were the most numerous, followed by Styrofoam. Of significance, monofilament and particularly ghost nets, were relatively rare but nylon salt sacks were numerous. Density maps for seabird species were compared with density maps of marine debris types and overlap was quantified using Arc-Map and GIS methods. Results indicate that seabirds that consume plankton have significant overlap with areas of highest density of plastic items. The greatest potential for negative interaction between seabirds and marine debris is likely due to ingestion of plastic items by planktivores, including species for which these detrimental effects have not yet been documented.
Determining Fatty Acid Turnover Rates in Captive Black-Legged Kittiwakes: Is a Moment on the Lips a Lifetime on the Hips?

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The use of fatty acids (FAs) as biochemical markers of marine diets has become increasingly popular to fine-tune seabird dietary information by characterizing the species consumed. FA analysis can be used to estimate diets at discrete time scales (days-weeks), depending on the tissue type analyzed. However, to date there are no published peer-reviewed studies that address exactly what the time frame of fatty acid integration into a predator's tissues is. We used captive Black-legged Kittiwake (Rissa tridactyla) chicks (n=12) fed known diets of California Squid (Loligo opalescens), Sprat (Sprattus sprattus), or Capelin (Mallotus villosus) to test 1) whether serum and adipose tissue FAs can be used to infer their known diets and 2) the period of time that FAs from the diet are incorporated into chick serum and adipose tissue. We implemented classification and regression tree analysis (CART) because it is a non-parametric non-linear multivariate model that does not have strict requirements of normality and homoscedasticity like discriminant function analysis or principal component analysis. Significant differences were seen in FA profiles that were consistent with the new diet and represented multiple time frames of dietary assimilation. Adipose tissue and serum FA signatures reflected the new diet after 1 week and 24 hours respectively, indicating that FAs from the new diet had fully integrated in these time frames. By accurately defining these discrete time scales of FA incorporation, seabird dietary pictures are further elucidated which is critical to our understanding of their ecology and interactions with contiguous marine trophic levels.

†Marine Habitat Selection by Breeding and Non-Breeding Marbled Murrelets in Summer: The Influence and Interaction of Fine Scale Oceanographic Processes and Terrestrial Habitat

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The Marbled Murrelet (Brachyramphus marmoratus) is a threatened seabird that depends on both terrestrial old-growth habitat and coastal marine areas for survival and reproduction. While huge advances have been made in our understanding of marbled murrelets over the past decade, significant gaps still remain. In particular, it is unclear how oceanographic processes affect choice of nesting and foraging locations on a fine scale, and how these processes interact with terrestrial factors to produce “good breeding habitat” in coastal British Columbia. While insufficient nesting habitat may directly limit murrelet populations, proximity of nests to productive marine areas may in turn limit nesting habitat availability and/or restrict murrelets to smaller, less productive marine foraging areas. Oceanographic conditions can also limit seabird populations independent of terrestrial habitat. From 1998 to 2002, 507 marbled murrelets were captured and radio-tracked over the breeding season in Desolation and Clayoquot Sound, producing a unique dataset of the marine use and attributes (i.e., sex, breeding stage) of individual murrelets at these two sites. Using geographical information systems, fine scale oceanographic data, and kernel home range methods, we examined spatial patterns of marine use by radio-tagged marbled murrelets, and how oceanographic conditions (e.g., tidal velocity, SST, bathymetry) and terrestrial factors (e.g., distance to nest, proximity to streams) correlate with murrelet marine habitat selection. By categorizing radio locations both temporally and with respect to breeding stage, we were able to compare marine habitat selection, and track seasonal changes in marine use patterns, for pre-breeding, breeding and non-breeding birds.
Population Trends of Breeding Marbled Murrelets in Northern California

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The marbled murrelet (Brachyramphus marmoratus) is a federally threatened seabird that nests in coastal old-growth forests in the Pacific Northwest. Reliable estimates of inland population trends are needed to assess the effectiveness of local and regional conservation strategies. We conducted land-based radar surveys of marbled murrelets at 14 sites in southern Humboldt County, California to estimate rates of change in the breeding population and to examine relationships between radar counted murrelets and oceanographic conditions, and regional at-sea counts of murrelets. Morning radar counts of murrelets varied significantly among and within sites but did not decline from 2002-2007. However, annual radar counts were negatively related to the mean sea-surface temperatures suggesting that marbled murrelet reproductive effort decreases with warmer sea-surface temperatures. These results support the need to consider oceanographic conditions when making decisions based on marbled murrelet inland survey data.

†Pigeon Guillemot Restoration Research in Prince William Sound, Alaska

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The population of Pigeon Guillemots (Cepphus columba) in Prince William Sound has declined by more than 85% from ca. 15,500 individuals in the 1970’s to ca. 2,000 in the year 2000. Two to three thousand guillemots were killed in the immediate aftermath of the Exxon Valdez oil spill (EVOS) in 1989, and sublethal effects from EVOS may have limited recovery for up to 15 years post-spill. But population recovery is now apparently limited by either indirect, long-term EVOS effects or factors unrelated to the spill. Because the Naked Island Archipelago formerly supported one third of the Sound-wide population of guillemots and intensive guillemot studies occurred there both pre- and post-EVOS, it is an appropriate site for investigating potential factors currently limiting recovery, specifically (1) forage fish availability, and (2) nest predation. A reconnaissance investigation in 2007 revealed that the number of guillemots nesting on the Naked Island Archipelago is now extremely low; only ca. 150 individuals were counted pre-nesting and only 13 active nests were found. Sand lance (Ammodytes hexapterus), the primary forage fish for guillemots in this locale, are present and utilized by seabird foraging flocks. We hypothesize that the unexpectedly low numbers of guillemots nesting on the Naked Island Archipelago in 2007 are a result of intense predation pressure from mink (Mustela vison), which were apparently introduced there 15-20 years ago. If this hypothesis is supported, then restoration of the guillemot breeding population in Prince William Sound will require mink control or eradication on the Naked Island Archipelago.
Inshore WA and BC Marine Bird Abundance Changes: Comparing Studies and Determining Causes

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The 1978-79 Marine Ecosystems Analysis Puget Sound Project provided baseline data for wintering marine bird abundance for the southern Strait of Georgia and adjacent waters. Since that time, census work has been limited to the Puget Sound Ambient Monitoring Program’s aerial surveys (1990-present), the BC Coastal Waterbird Survey (1999-present), our survey of marine bird abundance in NW Washington (2003-present), and Christmas bird counts (1970's-present). All four studies show widespread declines for many species. For instance, our data shows 19 of the 35 most common species in the 1970’s have declined by over 20%, including some species with declines exceeding 75%. These studies, however, disagree on abundance trends for some species. Here, we examine the complimentary and conflicting data between these studies to make the best possible assessment of the actual changes in marine bird abundance. We also use multivariate analysis to determine if taxonomic group, feeding guild, breeding range, or wintering habitat best explains abundance changes in this region.

Montrose Settlements Restoration Program—Restoring Seabird Populations on the Northern Channel Islands

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From the late 1940s to the early 1970s, millions of pounds of DDTs and PCBs were discharged into ocean waters off the Southern California coast. Almost all of the DDTs originated from the Montrose Chemical Corporation’s manufacturing plant in Torrance, California, and were discharged into the Los Angeles County Sanitation Districts’ wastewater collection system. The DDT-contaminated wastewater was discharged for years through the wastewater outfall into the Pacific Ocean off White Point, in a submarine area known as the Palos Verdes Shelf. Additionally, large quantities of PCBs from numerous sources throughout the Los Angeles basin were also released into ocean waters through the LACSD’s wastewater outfall on the Palos Verdes Shelf. As required by Superfund law, the trustees must use the settlement moneys to restore natural resources harmed by the DDTs and PCBs at issue in the settlement agreements.

Seabird restoration is one four restoration categories the Trustees have identified for restoration within the Southern California Bight. The Trustees selected seabird restoration actions that benefit species with evidence of injuries from DDTs or with past evidence of elevated levels of DDTs in their eggs. In 2006, the program began implementation of two seabird restoration projects on the Northern Channel Islands: Restore seabirds to Scorpion Rock and Orizaba Rocks off Santa Cruz Island and Restore Alcids to Santa Barbara Islands. The goal of these projects is to restore populations of Xantus’s Murrelets (Synthliboramphus hypoleucus), Cassin’s Auklets (Ptychoramphus aleuticus) and Ashy Storm-Petrels (Oceanodroma homochroa) through habitat improvement and social attraction.
Western Grebe Population Declines in the Salish Sea: Patterns and Possible Reasons

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Available data from annual ground and aerial surveys and Audubon Christmas Bird Counts indicate that Western Grebe (Aechmophorus occidentalis) numbers have declined considerably in the Salish Sea since at least the early 1990s. This numerical decline has coincided with changes in the abundance and distribution patterns their preferred prey species, Pacific herring. The Salish Sea is at the northern edge of the winter range for Western Grebes so they are likely very sensitive to changes in the ocean environment, including any factor that might influence the abundance and distribution of herring. It is unknown if the local population has actually declined or simply moved out of the area but a preliminary analysis hints that they may have simply shifted further south, towards California.

All Anchovy, All the Time: Recent Shifts in Prey Consumption by Breeding Seabirds in the Central California Current

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Seabird diet has been shown to be a good indicator of certain forage fish populations. Thus, seabirds can play a key role as indicators of major state shifts in the relative abundance of forage species. We assessed shifts in the diet of Central California Current seabirds spanning 2005-2007, in the context of continuous multi-decadal time series. These shifts differ from previous inter-annual changes in diet observed during typical fluctuations in the highly variable California Current system, including ENSO events. This may be indicative of more sustained changes from a diverse forage fish base to one almost solely comprised of Northern Anchovy (Engraulis mordax). We examine pathways and relationships between forage fish consumption and environmental indices to reveal potential causal linkages. Focal seabird species include Rhinoceros Auklets (Cerorhinca monocerata), Common Murres (Uria aalge), and Brandt’s Cormorants (Phalacrocorax pencillatus). Diet data was obtained from Southeast Farallon and Ano Nuevo Islands in Central California. We will explore short and long-term consequences of these shifts toward low forage fish diversity for both mid and upper trophic levels.
Derelict Fishing Gear in Puget Sound and the Northwest Straits: Past, Present, and Future Threats to Marine Wildlife

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Derelict fishing gear--lost or abandoned commercial and recreational fishing nets, lines, pots, and traps that sit or float underwater--can remain in the marine environment for years. Commercial fishing nets can trap and kill marine wildlife, as well as pose a threat to navigation and commercial, recreational, and research divers. In Puget Sound and the Northwest Straits, derelict fishing gear has been inflicting mortality on local and regional species for decades. The Northwest Straits Commission (NWSC) is leading efforts to survey and remove derelict fishing gear throughout Puget Sound. Since 2002, the derelict gear removal program has focused on surveying for high concentrations of lost gear, removing gear and quantifying the impacts of the gear to marine species in the greater Puget Sound ecosystem. To date, our team has removed over 600 derelict fishing nets (approximately 160 acres of net) and restored approximately 120 acres of marine habitat. From these nets, we have documented 17 dead marine mammals, 214 dead birds, 904 live and dead fish, and 16,875 live and dead invertebrates. As these data provide just a snapshot in time of the species being killed and harmed by derelict gear, we are conducting studies of species impacted over time, by tagging and tracking species caught in derelict nets to estimate “turnover rate”. Additional studies are focusing on biological hotspots (MPAs, haul-outs, wildlife refuges) to refine estimates of derelict gear impact on marine species of conservation concern and monitoring areas where gear has been removed to document habitat restoration.

A Multi-Colony Comparison of the Diving Behavior of Little Auks (Alle Alle)

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The purpose of this study was to compare the diving behavior of little auks from three colonies with distinct oceanographic conditions. We hypothesized that the diving behavior of little auks foraging on large prey (Calanus hyperboreus) in cold Arctic water differs from those foraging in warmer water on smaller prey (Calanus glacialis and Calanus finnarchicus). We predicted that little auks feeding in Arctic water off the East coast of Greenland would have shallower, shorter dives made less often than those foraging in warm water off the West coast of Spitsbergen. Time depth recorders were deployed on adult breeding little auks at three locations: Kap Höegh in western Greenland (KH; 0°C water), Hornsund Fjord in southwestern Spitsbergen (HF; 4°C water), and Kongsfjorden in northwestern Spitsbergen (KF; 5°C water). The average length of dives for KH, HF, and KF were 32.6s, 37.0s, and 36.2s, respectively, and the mean maximum depths for the three locations were 10.0m, 8.8m, and 10.9m. The average time between dives was greatest in Greenland (KH 284.1s; HF 193.0s; KF 224.1s), and the number of dives per 24 hours was lowest (KH 261; HF 460; KF 387). Taken together, these results suggest that little auks foraging in cold Arctic water off the coast of Greenland expend less energy diving than those foraging on smaller prey in warmer water off the coast of Spitsbergen. Our results suggest that increased warming of Arctic waters and concomitant changes in prey could increase energetic costs for this species.
Restoring Seabird Breeding Habitat in the Aleutian Islands: Conservation in Action

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The Aleutian Island archipelago supports many of the largest seabird colonies in the northern hemisphere, but introduced rats (Rattus spp.) have extirpated colonies on some of the islands and currently threaten others. Island Conservation, The Nature Conservancy, and the U.S. Alaska Maritime National Wildlife Refuge have partnered to restore seabird habitat in the Aleutian Islands by removing introduced rats. As part of a multi-faceted program designed to prepare for restoration efforts on large islands, a trial eradication was conducted on seven small islands in the Aleutian chain in 2006. A conservation bait containing the rodenticide brodifacoum (25 ppm) was broadcast by hand on 5 islands while 2 islands were used as untreated controls. The efficacy of the bait was measured using radio collared rats, and the impact to non-target species, particularly granivorous Song Sparrows (Melospiza melodia), was monitored using mean call rates collected with automated recording devices and by point counts. All radio collared rats (n= 44) were recovered dead during the trial; 39 (88%) were found below ground, reducing the likelihood of secondary exposure to scavenging birds. While mortality of individual song sparrows was observed, and song sparrow abundance and call rate declined over the trial period, the declines occurred on both treatment and control islands and there was no significant difference between them. These results suggest that mitigation may be required for at-risk landbirds in some full-scale eradications, but population extirpation is not expected, and populations are likely to recover quickly once released from rat predation pressure.

Habitat Restoration for Cliff and Crevice-Nesting Seabirds on the Farallon National Wildlife Refuge

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Ashy Storm-petrel (Oceanodroma homochroa), Brandt’s Cormorant (Phalacrocorax penicillatus), Common Murre (Uria aalge), Pigeon Guillemot (Cepphus Columba), and Cassin’s Auklet (Ptychoramphus aleuticus, have benefited from three habitat restoration projects on Southeast Farallon Island (SEFI). Prior to its addition to the Farallon National Wildlife Refuge in 1969, SEFI was used as a lighthouse station, a weather station, and military outpost during World Wars I and II. Human activities left behind infrastructure which presents hazard to seabirds or impacts habitat. Infrastructure and debris is removed when funds and opportunities become available. These three projects experimented with a different approach: recycling human debris into bird habitat and making human structures “bird-friendly”.

In 2000 nesting crevices for Cassin’s Auklets and Pigeon Guillemots were constructed from an derelict concrete building foundation. Concrete rubble was piled around an interior frame made of steel and wooden nesting boxes, resembling an igloo from the outside. Biologists have used the “stone igloo” as a monitoring blind to document the colonization of the habitat since the first Cassin’s auklets began nesting there in 2001. Removal of the concrete foundation itself created additional auklet nesting habitat by making the soil again available for burrow nesting seabirds.

In 2004 another concrete structure, which had posed a drowning hazard for seabirds, was demolished. The concrete rubble and other rocks were used to create cliff nesting habitat for Common Murres and Brandt’s Cormorants. Four hundred Brandt’s Cormorants and 420 Common Murres began using newly created habitat during the first breeding season.

The third project involves rebuilding a historic trail to expand habitat for crevice nesting seabirds. The trail was constructed in the late 1800s, is a registered National Historic Landmark, and its rock walls are used by nesting Ashy Storm-petrels, guillemots, and auklets. The reconstruction project was designed to maintain the historic elements of the trail and provide nesting crevices for seabirds.
Flexible Foraging by Murres in the Face of Changing Capelin Availability

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Common Murres Uria aalge in Newfoundland specialize on capelin Mallotus villosus. The timing and duration of capelin spawning in relation to chick-rearing affects the foraging effort and efficiency of provisioning murres. Changing capelin availability necessitates flexible foraging to facilitate successful reproduction. We investigated the foraging ranges and diet choices of parental murres at the species’ largest colony (Funk Island) during 2 years when capelin availability and size distributions were strikingly different. In 2005, capelin spawned early (resulting in poor overlap with chick-rearing), were smaller and their density declined by an order of magnitude (trawl data). Parental murres responded by increasing the distance they traveled to forage by 36% in 2005 (mean 63.1 km compared to 46.5 km in 2004) and preferentially selecting larger capelin for their chicks. Selection of large but scarce capelin maximises energy delivery to chicks when foraging effort increases. These responses show flexible foraging by murres, but lighter fledglings in 2005 suggests that the high energy and time involvements associated with long trips reduced breeding success when capelin availability and conditions were significantly reduced.

Status of Breeding Black Oystercatchers in the Strait Of Georgia, British Columbia

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There is growing interest among some conservation agencies to use the Black Oystercatcher (Haematopus bachmani) as an indicator of coastal ecosystem health. This species is a large, long-lived shorebird with a global population of 10,000 individuals occurring at low densities along the Pacific coast from the Aleutian Islands to Baja California. Vermeer and others (1989) conducted the only region-wide survey of nesting Black Oystercatchers in the Strait of Georgia in 1987. Hazlitt (2001) suggested the Strait of Georgia population was undergoing an increase. To assess the state of the oystercatcher population in the southern Strait of Georgia, we re-surveyed known and potential nesting sites in the area in 2005-2006 to count breeding and non-breeding birds. Our results indicate that overall the 2005-06 oystercatcher population in the Strait of Georgia remained stable or possibly increased somewhat from 64 nesting pairs in 1987 to 80 nesting pairs in 2005-06. Repeat surveys will be used to monitor the efficacy of nesting islet closures in Gulf Islands National Park Reserve. Through the Black Oystercatcher working group, research has expanded with banding and telemetry work in 2007 to look at movements between winter and summer habitats and between populations.
Assessing Seabird Mortality Following Marine Oil Spills in Alaska: Lessons from the M/V Selendang Ayu Spill

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The conceptual methodology for assessing bird mortality following marine oil spills is the same regardless of the spill’s location. Ideally, the following information is required: the trajectory of the oil, the abundance and distribution of birds in the vicinity of the spill (i.e., what is at risk), the proportion of the oiled birds that go ashore either because they are sick or because they wash ashore dead, persistence of carcasses following beaching, searcher efficiency (i.e., carcass detection probability) of beach survey crews, and background mortality (i.e., what proportion of the birds washing ashore are due to “normal” mortality factors). In remote areas, like much of Alaska, it may be infeasible to regularly survey all the beaches where carcasses could occur in order to determine deposition over time, and logistics may delay survey initiation until some days after a spill. Both of these conditions occurred following the M/V Selendang Ayu spill at Unalaska Island, Alaska in 2004. In such cases, sound statistical sampling and experimental design are required to efficiently and accurately estimate the many parameters needed for estimating mortality. While restoration programs typically do not fund preparations for future spills, it would behove agencies to prepare for future spills by gathering both successful protocols used for past for mortality assessments and stockpiling the associated field materials, e.g., bird carcasses for persistence studies, drift blocks, etc. Preparations would be improved by encouraging publication and critical review of protocols.

†Gulls Prevent Ant Infestation in a Blue-Footed Booby (Sula Nebouxii) Colony

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We have documented three predators inside the colony of Blue footed Booby (Sula nebouxii) nesting at Isla El Rancho, Sinaloa, Mexico: gulls (Heermann’s, Larus heermanni, and Ring-billed, L. delawarensis), and Southern Fire Ants (Solenopsis xyloni). From 2003 to 2007 we evaluated the factors that could promote depredation, through nest monitoring and baiting experiments. These experiments consisted of pieces of mullet with sardine oil placed within the colony, both available to gulls, and protected from them by wire cages. Gulls predated eggs, albeit with low intensity, and mostly when nests were abandoned by the parents. Presence of gulls inside the colony depended mainly on the amount of regurgitated food that fell to the ground during chick feeding. Gulls concentrated in the inner parts of the colony which had more chicks and, hence, more food, and where visibility was improved by the absence of vegetation. Ants predated chicks, and commonly raided nests with small chicks at the edge of the colony, near vegetation, during the early or late hours of the day. Our experiments showed that when the gulls could not remove discarded food, ants were able to reach every place in the booby colony in less than 30 min, and infest it accordingly. As a result, in the absence of gulls, nests with small chicks in the central part of the colony would also be susceptible to ant depredation.
Status of the Highly Endangered Chinese Crested Tern in the Matzu Archipelago of Taiwan

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The Chinese Crested Tern (Sterna bernsteini) was first discovered in 1863. There are only a few records of this species after that. In 1937, 21 were found and killed on islets near Qingdao in the Shandong Province of China. Thereafter, there is no reliable record of this species until the year 2000. Most biologists thought that this species had become extinct. In 2000, a photographer, Chieh-de, Liang, found 4 pairs of adults, each with a chick, when he was making a film about the terns in the Matzu Archipelago. These islets are adjacent to mainland China but are claimed by Taiwan making them a politically sensitive area to work in. Since 2000, Chinese Crested Terns have been found breeding on the islets of Matzu from May to September every year. In the last seven years, the largest number of adults recorded in one year is 12 and the smallest is 1. They have been observed breeding every year except 2001 and 2003. To protect this imperiled species, the Taiwanese Government has declared 8 islets in the Matzu archipelago ‘preserved areas’. No one is allowed to go ashore during the breeding season. But there are still some problems that need to be addressed such as overfishing and illegal egging by local Chinese fishermen. To solve these problems, cooperation between the governments of Taiwan and China is inevitably necessary in addition to research to understand habitat needs, diet, and migration of this species.

Cassin’s Auklet (Ptychoramphus Aleuticus) Burrow Creation Beneath Synthetic Boardwalk on the Farallon National Wildlife Refuge

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Researchers on the Southeast Farallon Islands have observed that Cassin's auklets Ptychoramphus aleuticus often dig burrows next to objects such as rocks or manmade debris. In the fall of 2000 over 248 meters of dilapidated boardwalk was replaced on the island with recycled plastic lumber. The boardwalks were designed to facilitate the traversing of the island by researchers, reduce the incidents of crushed burrows of Cassin's auklets and Rhinoceros auklets Cerorhinca monocerata and to provide additional burrowing habitat for the birds. Modifications to the plank layout of the boardwalks (basically skipping every fourth plank) were incorporated to further facilitate the excavation of burrows by the auklets. Monitoring of the boardwalks for burrow creation began in summer of 2001 and has been conducted since. Initial burrow creation showed the immediate success of the venture. 52 burrows were identified at the end of the breeding season in August 2001. By June of 2004 138 burrows were identified along the boardwalk and were sampled with a low-light burrow camera with a 6’ long flexible shaft. Of the 138 burrows 67.4% were occupied by Cassin's auklets, an occupancy rate comparable to that of natural habitat index plots where 60-65% is normal. Rhinoceros auklets occupancy was much lower with only one occupied burrow. Most recent surveys in 2007 indicate an overall decline in burrow creation with only 99 burrows found and a corresponding occupancy of 34.3% recorded a fact that is also mirrored in the naturally created burrows. Nonetheless the construction of boardwalks on Southeast Farallon Island can be considered a successful habitat restoration and enhancement project. It protected habitat and the auklet trough design facilitated nesting by auklets within the first year.
Tidal Energy Potential in Puget Sound

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Presentation will highlight the potential of tidal energy development in Puget Sound from a technological, economic, and environmental standpoint. Discussion will also include the current status of tidal energy development around the world, as well as the status of Snohomish PUD’s studies to explore the tidal energy resource in the Puget Sound. Adam will also briefly cover the general need for the identification and development of new, renewable energy resources in our region.

Fall Migration, Timing, and Wintering Sites of Columbia River Estuary Caspian Terns as Determined by Satellite Telemetry

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Satellite telemetry was used to determine fall migratory movements of Caspian Terns (Hydroprogne caspia) breeding in the Columbia River Estuary, Oregon, USA. Two captive terns at a rehab center were monitored four months to develop an optimal harness design. Testing a wide variety of sports fabrics and fittings we chose a yoke-style design of high impact 3 mm neoprene backed with Lycra on the inner-facing side. We used 18 gram solar-powered PTTs to mark 7 terns at the East Sand Island colony in August 2005. All terns explored the Columbia River Estuary, Willapa Bay, and Puget Sound before migrating south through the Willamette Valley, Oregon and Central Valley, California. Four terns spent a few weeks at the Salton Sea, California, before settling in Mexico. One tagged tern wintered widely across the Mexican state of Guerro verging on Oaxaca. Three terns wintered in the wetland complex of Bahia de Topolobampo and Bahia Santa Maria, Sinaloa. In Google Earth we plotted ideal locations for strategic field surveys along the migratory routes used by our marked terns, and traveled to sites in Southern California and Mexico. These surveys yielded 112 band sightings at the Salton Sea (9/07), and 12 more at the Rios Quetzala and Pagayo, Guerro, Mexico (1/06). We also observed 14 new species of fish consumed by wintering terns. This initial documentation of the migratory movements and winter foraging ecology of Caspian Terns could prove useful in future management of the west coast population of this species.
Local Science to Global Conservation: Perspectives from Southern Ocean Seabirds

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Marine environments and their inhabitants are amongst the poorest known and most threatened of global ecosystems. Research on seabirds has been critical to many of our key advances in understanding predator-prey-environment interactions in marine systems and for developing practical solutions to related problems. I illustrate this with examples of how data on diet, demography and distribution of Southern Ocean albatrosses, penguins and petrels were combined to address issues of conservation and fisheries management. To extend these achievements to deliver sustainable management of marine resources, with adequate safeguards for dependent species, also requires understanding how to apply good science in the relevant economic and political contexts. To address these and other seabird conservation priorities will need enhanced multidisciplinary cooperation and collaboration in collection and analysis of data, in building and testing models, and in advocating cost-effective solutions. I provide some examples of new and potential initiatives, with particular reference to the Pacific.

†Estimating Numbers of Breeding Auklets on a Colony that Cannot be Accessed by Traditional Methods

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Breeding population estimates of the Cassin's Auklet (Ptychoramphus aleuticus) and Rhinoceros Auklet (Cerorhinca monocerata) on Castle Rock National Wildlife Refuge are hindered by crepuscular or nocturnal colony activity, burrow-nesting habits and restricted access. Additionally, Castle Rock cannot be accessed during the breeding season because of disturbance to burrow-nesting and surface-nesting seabirds. A remotely controlled thermal video camera was used to establish plots, determine a ratio of species using burrows and estimate occupancy rates of auklet burrows. In 2007, we estimated burrow occupancy and the total number of auklet nest cavities to estimate populations of Cassin’s and Rhinoceros auklets breeding on the island. The total number of nest cavities available to auklets during the breeding season was estimated by a post-season burrow count. A sub-sample of burrow entrances was examined for multiple nest cavities. Greater than 85% of all auklet burrows were occupied during the 2007 breeding season. The post-season count of auklet burrow entrances was 1126 over an area of approximately 3 hectares. Of these entrances, we estimate 328 had two nesting cavities and 141 had a single nesting cavity connected to a second burrow entrance. Our preliminary estimate of available auklet nesting cavities during the 2007 breeding season is 1313, with at least 1116 cavities occupied by breeding pairs of auklets. Previous estimates used occupancy rates from other seabird colonies and assumed one burrow entrance led to one nesting cavity. Our methods are applicable to other colonies where access to burrows during the breeding season is not possible.
Seabird Bycatch in the West Coast Groundfish Fishery: A Preliminary Assessment

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The National Marine Fisheries Service’s (NMFS) Northwest Fisheries Science Center administers two observer programs that collect fisheries data essential to the management of the U.S. west coast commercial groundfish fishery. Vessels targeting groundfish vary in size, areas/depths fished and catch multiple groundfish species including sablefish (Anoplopoma fimbria), Pacific hake (Merluccius productus), assorted flatfish species and rockfish (Sebastes sp.) utilizing various types of gear including trawl nets, demersal longline, pot/traps and fishing rods. All factory vessels that process hake at-sea have carried two observers since 2001; other fleets have lower observer coverage (as a percentage of landed catch) ranging over the years from 10-25% of the bottom trawl fleet, 6-35% of the sablefish fleet, <1-10% of the non-sablefish fleet, to <1-8% of the nearshore fleet. Data collected includes information on fishing effort, fish catch and age structure information, in addition to any bycatch of marine mammals, seabirds or sea turtles. Low seabird bycatch occurred in the hake fleet between 2002 and 2006; the largest number of seabirds observed was six northern fulmar (Fulmarus glacialis) in 2004. Observed seabird bycatch in the bottom trawl fleet was higher; the largest number of seabirds observed was 36 common murres (Uria aalge) in 2003. In the sablefish fixed gear fleet, the largest number of seabirds observed was 12 black-footed albatross (Phoebastria nigripes) in 2005 and no seabird bycatch was observed in the other fleets. Efforts are underway to characterize these fleets and focus on reducing seabird bycatch in the appropriate fleets.

Economic Growth and Wildlife Conservation: A Fundamental Conflict

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Economic growth is an increase in the production and consumption of goods and services. It entails increasing population times per capita production and consumption. It is indicated by increasing gross domestic product (GDP). It occurs as natural capital (such as soil, timber, and water) is reallocated from the economy of nature, where it comprises wildlife habitats, to the human economy, where it is converted into manufactured capital, consumer goods and services, and byproducts (pollutants). Because of the trophic structure of the economy, economic growth is eventually dependent upon the liquidation of natural capital, whereby the withdrawal and conversion of natural capital is permanent with regard to conservation purposes. Using the framework of limiting factors introduced by Aldo Leopold in Game Management, the liquidation of natural capital constitutes an erosion of “welfare factors,” and numerous byproducts or incidental effects of the economic production process (e.g., pollution, invasive species, global warming) constitute a collection of “decimating factors”. Therefore, economic growth may be classified as the limiting factor for wildlife in the aggregate. Some assume that technological progress may reconcile the conflict between economic growth and wildlife conservation, but reconciliation does not occur because of the interdependency between technological progress and economic growth at current levels of technology. The fundamental conflict between economic growth and environmental protection is generally understood among ecologists and ecological economists, but is obfuscated in political circles. Wildlife scientists and managers have a unique role to play in clarifying the relationship between economic growth and wildlife conservation.
The Importance of Juvenile Pacific Herring *Clupea Pallasi* to Wintering Seabirds in Prince William Sound

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Pacific herring *Clupea pallasi* are an important food source for seabirds in Prince William Sound (PWS) Alaska. The PWS herring population has not recovered since its collapse in the early 1990s. Juvenile herring over-winter in several bays, separately from adults, often at depths less than 30 meters. Little is known about winter foraging dynamics of seabirds in PWS although persistent population declines have been evident for some species that over-winter there, notably Marbled Murrelet (*Brachyramphus marmoratus*). It is possible that some species depend on herring availability in winter to meet energetic demands. We conducted hydroacoustic surveys in historic juvenile herring wintering areas in March and November 2007. Simultaneously, bird observers recorded all seabirds encountered along a fixed transect. Trawl surveys established species composition and age class of schools. We modelled the relationship between seabird density and the composition and structure of fish schools. In March 2007, juvenile herring were found in three of seven bays surveyed. Spatial correlation with juvenile herring in these bays was strongest for Black-legged Kittiwake (*Rissa tridactyla*) and Marbled Murrelet. Further work is required to develop an understanding of the role that winter availability of juvenile herring may play in regulating seabird populations in PWS.

Movements of Kittlitz’s Murrelets at Kodiak Island, Alaska

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We studied movements and activity patterns of Kittlitz’s Murrelets (*Brachyramphus brevirostris*) at two sites in western Kodiak Island, Alaska, in July 2007. One site had only Kittlitz’s Murrelets visiting the area. Movement rates of “murrelet-like” radar targets varied by hour of the day, being very low in the evening, high in the early morning, and zero in mid-morning. Movement rates also varied by the amount of incident light, with some birds moving during complete darkness, many moving at 0.1–1,000 lux, and none moving at >1,000 lux. There appeared to be substantial within-day variation in the proportion of targets exhibiting straight-line flight behavior from sunset to after sunrise. We also recorded 78 Kittlitz’s Murrelets during the audiovisual sampling. Movement rates varied by hour of the day and incident light and were fairly similar to those seen on radar. We observed aerial displays by Kittlitz’s Murrelets at one site and believe that these are the first serial displays of the species ever observed. Although sample-sizes for this pilot study were limited, many of the movements and behavior patterns seen in Kittlitz’s Murrelets are similar to those seen in closely-related Marbled Murrelets.
Moving and Rearing Albatross Chicks to Support Short-Tailed Albatross Recovery: Year 2 Results

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This pilot translocation and rearing project is a preliminary step to conducting a translocation of Federally endangered short-tailed albatross (Phoebastria albatrus) chicks. The Short-tailed Albatross (STAL) Recovery Team has indicated that additional STAL breeding colonies must be established in order to achieve recovery. By translocating STAL chicks to a new safe colony site, we hope to facilitate new colony formation, thereby expediting the species’ recovery. This is the second year of this pilot project. In the first year (2006), four of ten Laysan albatross chicks translocated from Midway to Kilauea Point fledged successfully. Here we report the results of Year Two, translocation of black-footed albatross (Phoebastria nigripes) chicks to an artificial colony site in the Bonin Islands.

On March 20, 2007, ten black-footed albatross post-guard stage chicks, approximately 50 days of age, were captured at Nakodojima, a small island in the Bonin Island group, and moved about 5 kilometers to Mukojima, where an artificial colony was set up. Chicks were fed a diet of flying fish, squid, and sardine oil, supplemented with electrolyte solution and vitamins. One chick died on 4 April, apparently from suffocation during regurgitation; another may have succumbed when it fledged early (24 May). The remaining chicks fledged successfully from 4 to 14 June. Based on these results and our refined techniques, we plan to translocate 10 short-tailed albatross chicks to Mukojima colony site early in 2008. Initial progress report on the 2008 translocation will be presented if appropriate.

Integrated Weight Longlines With Paired Streamer Lines – Best Practice to Prevent Seabird Bycatch in Demersal Longline Fisheries

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To evaluate a new technology – integrated weight longlines (IW) – as a viable seabird mitigation technology for demersal longline fisheries, we compared three experimental mitigation treatments, IW line alone, IW with paired streamer lines (IWPS) and unweighted longlines (UW) with PS (UWPS), to a control of no deterrent (UW alone). Trials took place on two vessels targeting Pacific cod (Gadus macrocephalus) over a five-month period in the Bering Sea, Alaska, USA. We used multiple criteria for evaluations – catch rates of all taxa, seabird abundance and attack rate, and gear sink rate and performance – making this study the largest and most comprehensive experiment of its kind.

All mitigation technologies dramatically decreased seabird bycatch rates while having little to no effect on fish catch rates. Mitigation was more effective for surface foraging seabirds (Fulmarus glacialis and Larus spp.) than for diving seabirds (short-tailed shearwaters, Puffinus tenuirostris), reducing mortality rates by 91% to 100% and 80% to 97%, respectively. IWPS performed best, reducing surface forager catch by 100% and shearwater catch by 97%, relative to the control. IW alone and UWPS performed similarly reducing surface forager catch by 91% and 98%, respectively, and shearwaters catch by 87% and 80%, respectively. Seabird abundance and attack rate were poor proxies of seabird mortality, especially for IW gear. IW lines reduced the distance astern that birds have access to sinking baits by near half and its handling qualities were superior to UW. We conclude that IW longlines deployed with paired streamer lines comprise the core of best management practices for seabird conservation in demersal longline fisheries using autoline systems.
The Steady State Economy and its Relationship to Wildlife Conservation

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Economists and political leaders habitually support economic growth as a societal trend and policy goal without an understanding of the ecological ramifications. As a result, policy makers promote economic growth by setting fiscal, monetary, and trade policies to expand human populations, infrastructure, cities, and production and consumption of goods and services. These policies and the ensuing economic growth generate many costs to ecological systems, natural resources, and wildlife populations. Wildlife professionals may help bring to light the conflict between economic growth and wildlife conservation. To the extent they are effective, in collaboration with allied natural resource professionals, there should at least be some reduction in the rate of economic growth. Ultimately, however, for ecosystems and wildlife populations to stabilize, a new and sustainable macroeconomic policy goal is required: the steady state economy. The steady state economy is characterized by stabilized population and per capita production and consumption within ecological carrying capacity. When the steady state economy reaches equilibrium (albeit a dynamic equilibrium) with its containing ecosystem, wildlife populations and biodiversity in general can be maintained. Many people are reluctant to support the establishment of a steady state economy because of concerns ranging from personal finances to implications for government. Some of these concerns have been dramatically overstated, however. The key feature of a steady state economy, sustainability, trumps any policy concerns and compares favorably to the alternatives (continued reckless growth or recession).

Annual and Seasonal Variation in Nearshore Prey Availability Associated with the Record Arctic Pack Ice Minimum of 2007

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The record retreat of pack ice in 2007 resulted in the Arctic Basin having 50 percent of the ice cover present in the 1950s and 1960s. For species dependent on the sympagic zooplankton and fish community associated with pack ice, the drastic reduction in ice extent could be expected to have major effects on trophics and distribution. We examined temporal variation in prey of the arctic race of Black Guillemot (Cepphus grylle mandtii), a pack ice obligate, by conducting daily observations of prey items provided to nestlings from late July to early September, 2006 and 2007. Pack ice retreated <30 km from the colony in 2006 and arctic cod (Boreogadus saida) comprised >90 percent of prey with no seasonal trend. The dramatic 2007 ice retreat (from <20 km to >250 km from the colony) was associated with a decrease in the percentage of arctic cod (from >90 percent to <20 percent per day) with distance to ice explaining >75 percent of the daily variation. The switch from a sympagic prey to nearshore demersals, primarily sculpin (Myoxocephalus spp.), resulted in annual and seasonal decreases in guillemot nestling growth and increased frequency of brood reduction.
Patterns of Timing of Breeding in Four *Aethia* Auklet Species in the Aleutian Islands, Alaska.

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As top marine predators, seabirds are sensitive to fluctuations in the marine environment that affect their prey supply. Therefore, parameters of seabird breeding biology may be useful indicators of climatic changes. Variation in nesting phenology has been suggested to reflect changes in marine systems, as timing of breeding in seabirds presumably is based on environmental cues prior to the breeding season. As part of the seabird monitoring program conducted by the Alaska Maritime National Wildlife Refuge, data on hatch and fledge dates are collected for a number of species at several sites across the Aleutian Islands. Our objective was to provide an introductory exploration of nesting phenology of four species of *Aethia* auklets in the western Aleutian Islands. *Aethia* auklets comprise a little-studied suite of closely-related species, and while there are data for individual species, little work has looked at timing of breeding within this group as a whole. We describe timing of breeding of Least (*Aethia pusilla*), Crested (*A. cristatella*), Whiskered (*A. pygmaea*), and Parakeet Auklets (*A. psittacula*) using a 17-year dataset from Buldir Island. We also examined variation in phenology across years and between two separate populations on different islands. Finally, we identified avenues for future investigations.

Marine Wildlife Areas – Are They Possible?
A Case Study of the Scott Islands Marine Wildlife Area Establishment Process to 2007

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This paper will provide the background to the process for establishment of a Marine Wildlife Area (MWA) using the Scott Islands MWA initiative as an example. The legislative authority for establishment of MWAs was provided by an amendment to the Federal *Canada Wildlife Act* in 1994. At that time, the Canadian Wildlife Service, Environment Canada undertook an assessment of the Scott Islands breeding seabird populations, particularly their marine foraging areas, as well as the use of this marine region by non-breeding seabird species. This assessment phase used pelagic datasets, assessments of oceanographic conditions and observations of seabird researchers working on Triangle Island (one of the Scott Islands) to describe the significance of this marine area to seabirds. In addition, telemetry data gathered for foraging Cassin’s Auklets (*Ptychoramphus aleuticus*) (3 years) and Rhinoceros Auklets (*Cerorhyncus monocerata*) (1 year) helped confirm the relative area of marine waters used by breeding seabirds from Triangle Island. For the purposes of discussion and consultation, a marine study area was identified at the end of the assessment phase. The paper will further present the issues affecting seabirds in this region, the steps taken in preparation for public consultation and the impediments that slowed meaningful progress in furthering the establishment process. The Scott Islands Marine Wildlife Area establishment process continues to date with no specific target for completion. Nonetheless, some recent positive signs for continuing of the Scott Islands MWA process and a likely path for its eventual establishment can be identified.
Laysan Albatross Reproductive Success is Linked to Foraging Location

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Albatross breeding success and breeding frequency have been linked to foraging distance. During chick provisioning, Laysan Albatross (Phoebastria immutabilis) forage in the North Pacific Transition Domain and along the continental shelf of Alaska. During the summer non-breeding period, albatross abundance increases along the continental shelf. To compare foraging strategies with reproductive success, we examined stable isotope ratios (δ15N and δ13C) of primary feathers for birds monitored for breeding success by the US Fish and Wildlife Service in 2005-06 and 2006-07 on the Midway Atoll National Wildlife Refuge. We also sampled feathers from birds salvaged from longline fisheries in Alaskan and Hawaiian waters, and feathers from birds collected a century ago from the Hawaiian breeding colonies. Delta-15N values were consistently bimodal, apparently reflecting a transition between foraging on (1) low trophic level squid in deep waters (depth), specifically the North Pacific Transition Domain, and (2) high trophic level squid on or near the continental shelf. Birds that fledged chicks two years in a row apparently did not forage near continental shelves, either at the end of chick rearing or throughout the summer non-breeding period. In contrast, many birds that fledged one or no chicks in two years apparently foraged at the shelf, although the majority of their foraging still occurred in deep water. Successful breeding year after year among Laysan Albatross pairs may be dependent upon the ability of each parent to reliably locate food within a threshold distance from the colony. This ability may be influenced by information gathered during the non-breeding season.

Health Assessments of Altricial Brown Pelican Nestlings

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We performed health evaluations of 30 nestling Brown Pelicans (Pelecanus occidentalis) to establish reference values for a wild population of birds during early development. Nestlings were sampled from one colony in 2005 and two colonies in 2007, and ranged in age from 19 to 40 d. Physical examinations were conducted to assess body condition, size, ectoparasite load, and signs of injury and other abnormalities. Blood samples were collected for hematological, plasma biochemical, and protein electrophoresis testing. The following values were determined: packed cell volume, white blood cell count and differential count, glucose, blood urea nitrogen, creatinine, sodium, potassium, CO2, amylase, lipase, calcium, phosphorus, cholesterol, triglycerides, uric acid, total protein, aspartate aminotransferase, alanine aminotransferase, lactate dehydrogenase, creatine phosphokinase, gamma glutamyl transferase, bile acids, prealbumin, albumin, and globulin concentrations. Nutritional evaluation included measurement of plasma vitamin A and E. Additionally, plasma antibody levels to Aspergillus spp and Chlamydia and Aspergillus antigen were measured. Values were evaluated in relation to age, year, colony, and were compared among broods.
†Prey Use of Common Murres (Uria aalge) at Two Colonies in California

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To test the hypothesis that Common Murres (Uria aalge) specialize on particular species and sizes of prey, we examined murre prey deliveries at two inaccessible colonies in California that are 490 km apart: Devil’s Slide Rock and Castle Rock National Wildlife Refuge. Prey items were identified by extracting still images of prey deliveries from digitally recorded high resolution video. Prey characteristics including fin placement and distance between fins were measured to enable prey identifications. Total length of prey was approximated in relation to adult bill length. If Common Murres were using specific species or sizes of prey we would expect similarities in species or size across spatial and temporal scales. Further, we expected that prey items brought to the colony by birds with chicks would be similar to prey items brought in by birds not rearing chicks (e.g., non-breeders and failed breeders). Data from 2006 and 2007 at Devil’s Slide Rock are being compared to 2007 data from Castle Rock. In 2006 at Devil’s Slide Rock, the majority of prey items consisted of northern anchovy with smaller numbers of salmonids, smelt species, Pacific sand lance and clupeids (Pacific sardine / herring). Preliminary analyses suggest that there was no difference in size of prey brought in by birds without chicks compared to prey carried by chick-rearing murres. Variance in prey species and size was greater for murres without chicks than for chick-rearing murres. Results will be compared between years and colonies to further investigate whether murres are specializing on particular species and sizes of prey.

Colonial Waterbirds as Indicators of Exposure and Effects of Persistent Contaminants in the Georgia Basin

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Colonial waterbirds have proven to be useful monitors of the exposure and effects of persistent contaminants in marine and aquatic ecosystems. We have tracked chlorinated hydrocarbon and heavy metal contaminants in eggs of great blue heron (Ardea herodias) and cormorant (Phalacrocorax spp) since the early 1970s in the Georgia Basin region on the Pacific coast of Canada. Organochlorine pesticides in eggs declined sharply in both species during the late 1970s, after which there were minimal changes. PCBs in herons showed similar marked declines over time. However, over the period 1973 to 2000, PCBs in cormorant eggs showed no significant decline, despite regulatory bans and intensive efforts to clean up PCB-contaminated sites. Concentrations of polychlorinated dibenzo-p-dioxins (PCDDs) and furans (PCDFs) increased in eggs of both species during the 1970s and 1980s. Dominant PCDD/F congeners fell markedly in the early 1990s after pulp mills changed from molecular chlorine bleaching, and use of chlorophenolic wood preservatives and anti-sapstains was restricted. Toxic equivalent concentrations (TEQs) sufficient to produce embryotoxicity in heron chicks were measured in eggs from 1985-1991 at some colonies. Despite reduction in PCDD/Fs, estimated TEQs remained elevated throughout the 1980s at some urban heron colonies due to PCB contributions. Based on total TEQs and effects in siblings of the cormorant eggs analyzed here, cormorants may have exhibited significantly elevated EROD activity and/or brain asymmetries at all colonies from 1973-1989 and even at some colonies during the 1990s. Retrospective trends for polybrominated diphenyl ethers and mercury will also be presented.
Marbled Murrelet Population Size and Trend in the Northwest Forest Plan Area

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The Northwest Forest Plan is an ecosystem management plan for federal lands in the Pacific Northwest. As part of a program to evaluate the Plan’s effectiveness, Marbled Murrelet (Brachyramphus marmoratus) populations were monitored annually with a unified sampling design starting in 2000. Murrelets were sampled from boats using line transects with distance estimation, along the Washington, Oregon, and northern California coastline south to San Francisco. The sample area (about 8,800 km²) represents the near-shore marine waters associated with the Plan area, and was divided into geographic subareas corresponding to Conservation Zones 1 through 5 of the U.S. Fish and Wildlife Service’s Marbled Murrelet recovery plan. From 2000 to 2007, population estimates for the area ranged from 17,400 to 23,700 birds, with a 2007 estimate of 17,400 (95% confidence intervals: 12,800 to 21,909). Averaged over the 8-year period, murrelet densities were greatest in northern and central Oregon (3.9 birds/km²) and lowest south of Humboldt County, California (<0.2 birds/km²). The largest population was in Washington, which also had the largest area sampled. Trend analyses indicate that, for the 2000-2007 period, the estimated annual rate of population change over the entire sample area was -2.2%, with 95% confidence interval of -5.6% to +1.3% (P=0.19 for a downward trend); this rate suggests a decline of about 15% over the period. At the conservation-zone scale, confidence intervals for trend estimates are fairly large because of between-year variability, but data from most zones are consistent with a decline.

Hotspots on the Edge: Linking Seabird Abundance and Prey Availability in Shelf Ecosystems

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Dovekies (Alle alle) are the most abundant seabird in the Northwest Atlantic. Their distribution across the marine habitat is non-uniform and is influenced by the physical processes that concentrate their prey, which is dominated by Calanus copepods. In 2006, we investigated the association between Dovekie density and zooplankton abundance during spring and fall surveys conducted throughout eastern Canada. We surveyed 6883 km of ocean track and sampled mesozooplankton at 179 stations. We counted a total of 17,477 birds from 9 families with Dovekies representing 26% of the total observations. Calanus copepods were by far the most numerous, making up 80% of the total zooplankton sampled. We modelled Dovekie detectability and estimated densities using distance sampling methods (program DISTANCE), and examined the effects of region, observer, and various environmental factors. Adjusted Dovekie densities were compared to patterns of Calanus distribution and abundance. The spatial distribution of Dovekies strongly tracked prey concentrations with highest densities of both predator and prey along continental shelf edges. This suggests that Dovekies depend on stable prey availability at shelf edge upwellings and have the potential to be indicators of underlying ecological processes.
Post-Breeding Season Distribution of Black-Footed and Laysan Albatrosses: Inter-Specific Differences in Spatial Overlap with North Pacific Fisheries

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We integrated satellite-tracking data from black-footed albatrosses (Phoebastria nigripes; n = 7) and Laysan albatrosses (P. immutabilis; n = 18) with data on fishing effort and distribution from commercial fisheries in the North Pacific in order to assess potential risk from bycatch. We captured and satellite-tagged albatrosses at-sea in the central Aleutian Islands, Alaska and tracked them during the post-breeding season, July – October 2005 and 2006. In Alaskan waters, fishing effort occurred almost exclusively within continental shelf and slope waters. Potential fishery interaction for black-footed albatrosses, which most often frequented shelf-slope waters, was greatest with sablefish (Anoplopoma fimbria) longline and pot fisheries and with the Pacific halibut (Hippoglossus stenolepsis) longline fishery. In contrast, Laysan albatrosses spent as much time over oceanic waters beyond the continental shelf and slope, thereby overlapping less with fisheries in Alaska than black-footed albatrosses. Regionally, Laysan albatrosses had the greatest potential fishery interaction with the Atka mackerel (Pleurogrammus monoptyerygius) trawl fishery in the western Aleutian Islands and the sablefish pot fishery in the central Aleutian Islands. Black-footed albatrosses ranged further beyond Alaskan waters than Laysan albatrosses, overlapping west coast Canada fisheries and pelagic longline fisheries in the subarctic transition domain; Laysan albatrosses remained north of these pelagic fisheries. Due to inter-specific differences in oceanic distribution and habitat use, the overlap of fisheries with the post-breeding distribution of black-footed albatrosses is greater than that for Laysan albatrosses, highlighting inter-specific differences in potential vulnerability to bycatch and risk of population-level impacts from fisheries.


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Washington Sea Grant, in collaboration with the longline industry and NOAA Fisheries, conducted research on seabird mitigation gear during 1999 and 2000. Recommendations first resulted in adoption of streamer line gear by many freezer-longliners in 2001, followed by regulatory requirements implemented for all longline vessels in 2004. In 2004, groundfish observers also began recording results of their spot-checking the use of seabird mitigation gear on vessels 60 feet length overall and greater. Since then observers have checked >65% of longline sets and observed that single or double streamer lines were used in >95% of those sets. Compliance appears to be near 100% given allowances to not use seabird mitigation gear in heavy weather due to concerns for crew safety. Seabird bycatch has been reduced from an annual average (1993 to 2000) of 16,507 down to an annual average (2002 through 2006) of 5,137. The research indicated that streamer lines were especially effective for albatross. The average annual albatross bycatch for 1993 through 2000 was 1,051 while the annual average between 2002 and 2006 was 185. The research was originally designed to evaluate mitigation gear under commercial operations and to recommend actions that would be effective and relatively easy to use by fishermen. Based on this general evaluation of several years use of these measures it appears that those goals were met.
The Trouble with Trawlers and Seabirds in the North Pacific Groundfish Fishery(ies)

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The annual average seabird bycatch in the Alaskan trawl fishery between 2002 and 2006 was 1,363 seabirds (695 – 2,674). But what does this estimate mean and what constitutes the groundfish trawl fishery? From a monitoring standpoint, we know that there are unobserved mortalities of seabirds on trawl warps and third wires that do not get included in standard observer sampling protocols and are not represented in the estimate. Ad hoc recording of seabird/gear interactions and observer special projects do provide some information on these mortalities. Data recording issues prior to 2004 resulted in two alternative analysis providing different sets of numbers. From a fleet standpoint, the trawl fishery is composed of various sectors identified by vessel class, processing capability, areas of operation, target species, and other factors, all of which affect seabird interactions. Although problems exist, estimates derived from observer monitoring do provide important information upon which research and management decisions can be based. The greatest regional bycatch of seabirds occurs in the Bering Sea (993 annual average) followed by the Aleutian Islands (283) and Gulf of Alaska (87). The Pacific cod (Gadus macrocephalus) target fishery has the highest annual seabird bycatch (609) whereas Atka mackerel (Pleurogrammus monopterygius) is the lowest (100). While no Black-footed (Phoebastria nigripes) or Short-tailed albatross (Phoebastria albatrus) have been observed taken in any trawl fisheries, an annual average of 45 Laysan Albatross (Phoebastria immutabilis) are taken. Several additional studies help to inform us on seabird interactions with the Alaska groundfish trawl fisheries.

A Database of Seabird Distributions in California for Use in Oil Spill Response

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While the options for protecting seabirds are limited when an oil spill occurs, any response such as dispersant use, hazing, or recovery of live and dead birds is made more effective if the distribution of seabirds is understood. OSPR has supported the compilation of a historical database of seabird sightings that includes most historical studies in California spanning the years 1975-2007. The database includes over 610,000 km of survey effort and over 2.5 million sightings. Data sources include MMS ship and air surveys, NMFS Rockfish Cruise Surveys, DOD surveys, EPOCS cruises, OSPR training and spill response surveys, and other sources. The data are integrated so that multiple studies can be combined or separated, and so that new data collected during an oil spill response can be immediately integrated with historical data. This database and its associated access tools were used during the response to the recent Cosco Busan spill in San Francisco.
Recent Changes in the Reproductive Success and Numbers of Glaucous-Winged Gulls (Larus glaucescens) Breeding on Protection Island National Wildlife Refuge, Jefferson County, WA, USA

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Protection Island, Jefferson County, Washington is reported to support more than 70% of the seabirds breeding in the state. The number of Glaucous-winged Gull (Larus glaucescens) nests on Violet Spit, the site of the largest gull colony in the state, increased steadily from 1980 until 1993 (from 3512 to 5189). Since then the numbers have decreased to 2281. In 2005, a weak El Niño year, there was a catastrophic breeding failure with fewer than 100 chicks produced. Also in that year, the maximum number of Bald Eagles (Haliaeetus leucocephalus) observed on the colony at any one time reached 38. Eagle disturbance and increasing amounts of tall beach grass (Elymus mollis) in the colony may be contributors to the reduction in nest numbers.

Seabirds, Ice and Climate Change in Canada’s Arctic

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Impacts of climate amelioration are evident everywhere in the Canadian Arctic. In marine areas, the formation of sea ice in fall is becoming later and its break-up and disintegration in spring is becoming earlier. Sea-ice is a major physical determinant of many ecological processes in Arctic marine environments. Consequently, these changes have great significance for all Arctic marine ecosystems and for the characteristic community of birds that inhabits them. I describe changes that have taken place in marine areas of eastern Canada and consequent changes in seabird biology. The eventual shape of future bird communities is not hard to predict, given current climate models. However, changes in the short- to medium-term are unpredictable, because of lack of information on colonization rates and the progress of competitive interactions.
†California Central Coast Marine Bird Health Study

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The Central Coast Marine Bird Healthy Study (CCMBHS) is based out of California Department of Fish and Game Marine Wildlife and Veterinary Care and Research Center in Santa Cruz, CA. This study collaborates with Moss Landing Marine Laboratories, and aims to supply a quantitative demographic assessment of disease and other mortality factors affecting seabird populations in California. CCMBHS supplements existing beach survey programs, cultivates collaboration among scientists and rehabilitation centers, and provides a regional information center for federal state and local resource managers. Seabirds are important indicators for environmental change and marine ecosystem health. CCMBHS focuses on identifying and quantifying mortality events, species-specific disease factors, body condition and histology by conducting necropsies on specimens collected from beach survey programs, rehabilitation centers, and state and federal resource agencies. Field investigations to measure baseline health, entanglement of wild seabirds, and chronic oiling, are also conducted. In 2007 alone, there were two unusual investigated seabird mortality events: The Common Murre (Uria aalge) wreck of March 2007, and the Horned Puffin (Fratercula corniculata) mortality event of July 2007.

†Changes in Common Murre Colony Size and Reproductive Success on the Central Oregon Coast

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Common Murre (Uria aalge) colony size and distribution in Oregon have changed over the past 10 years, with many colonies on the northern coast declining while some central coast colonies have experienced rapid growth. This has been a period of markedly anomalous ocean conditions, with phase shifts in the Pacific Decadal Oscillation and variation in spring bloom phenology, but also a period of suspected increased Bald Eagle (Haliaeetus leucocephalus) disturbance to breeding Murres. From 1988-1998, the central coast colony Yaquina Head averaged approximately 43,700 (±7,970 SD) breeding Murres. By 2006, the population of breeding Murres at Yaquina Head had doubled, with over 90,000 birds, the highest since population monitoring began in 1979. The rapid growth of the colony has been documented annually, but the most recent estimates of reproductive output and disturbance rates were from studies conducted in 1998-2001. In 2007, we re-established observations using protocols similar to earlier studies. Across 11 plots, we found moderate hatching success of 70% (± 0.05 SE) and reproductive success rates of 54% (± 0.07 SE) and surprisingly low disturbance rates during chick-rearing. Population growth at the Yaquina Head colony is likely explained, in part, by the redistribution of birds from nearby colonies that are now abandoned. The relative attraction of Yaquina Head, however, whether it be “safety in numbers” related to eagle predation or increased reproductive potential due to good local foraging conditions, is unknown. Results from our comparative analyses will attempt to address these questions.
Assessment of the Parental Response to the Manipulation of the Cost of Flight and Brood Size in the Laughing Gull (Larus atricilla)

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Given their long life spans, seabirds are considered fixed investors. This implies that they reduce their yearly breeding effort so as to lower the potential impacts on future breeding events and on their own survival. We tested this hypothesis by analyzing the consequences of experimental increases in the cost of flight and brood size on parental care in the Laughing Gull (Larus atricilla), breeding on Isla El Rancho, Sinaloa, Gulf of California, Mexico. During the 2007 breeding season, we manipulated 74 pairs and broods by clipping 0cm, 3cm y 5cm of the edge of the primaries of one of the parents, and considered broods of 1 and 3 chicks. We monitored time of attendance and number of feeding bouts by each parent. When the manipulated parents were males, the female partner diminished their nest attendance time. On the contrary, when the manipulated parent was the female, the males increased their attendance time. Feeding bouts were more numerous in pairs with three chicks, and were influenced by feather clipping of the parent. Survival and body condition of chicks were affected negatively by adult feather clipping and by brood size. These results suggest that Laughing Gulls are flexible in their parental investment, as they exhibited some buffering of the effects of feather clipping by transferring the costs to their partners and chicks. Therefore, the fixed inversion hypothesis cannot be applied to all seabirds, and a buffering gradient might exist depending on the breeding capacity of the different species.

Interannual Variability in Breeding Parameters of the Red-Billed Tropicbirds (Phaethon aethereus) on Farallon de San Ignacio, Sinaloa: 2004 vs. 2007

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Breeding success and individual survival depend on the quality of breeding habitats. Changes in the attributes of these habitats can cause interannual variations in the supply of food to chicks, and in their growth, body condition, and age at fledgling. We studied Red-billed Tropicbirds (Phaethon aethereus) on Farallon de San Ignacio, Sinaloa, Gulf of California, Mexico, during the breeding seasons of 2004 and 2007 (January to May). During this period we made two 5-day visits per month. We determined hatching and fledging success, as related to parent attendance time in the first three weeks after hatching (parental care quality index) and monitored changes in growth rate (length of ulna, culmen, tarsus and mass), body condition (mass/culmen, mass/ulna), diet (from regurgitates), maximum diving deep of adults (through capillary tubes attached to rectrices). We found significant differences between years. Maximum diving depth of adults was 0.96m ± 0.66 in 2004, whereas it was 2.09 m ± 0.96 in 2007, suggesting that a larger foraging effort was needed in the later. Also, in 2004 body condition and growth rates of chicks were higher than in 2007. Hatching and fledging success depended on the quality of parental care, which was also higher in 2004 (average parental care index: 0.64 vs. 0.59, in 2007). Our data exhibited high interannual variability in breeding conditions in the region of the study site, and indicated that Red-tailed Tropicbirds adjust their breeding behavior accordingly to such variability.
Testing the Effect of Wind Parks on Habitat Use and Flight Behavior of Seabirds: The Case of Common Eiders

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Typically, ecological impact assessments (EIA) are conducted under time constraints which is making the collection of baseline data and the application of the Before-After-Control-Impact (BACI) design difficult. Here we report the results of a BACI study and “post-development” experiments testing the effects of a small wind park on abundance, distribution and behavior of wintering common eiders (Somateria mollissima), a large sea duck species. Our approach was based on the rationale that the probability to detect an impact increases with decreasing distances from the wind park. Since prey abundance is likely to drive the distribution of wintering eiders, we remove that confounding variable by (1) randomizing its effect over the study area and (2) by incorporating that variable in the analysis. We found very little evidence for a negative impact as we accepted the null hypothesis in most experiments. Only for the decoys experiment that we observed eiders avoiding to land and fly at close distance (100 m) from the wind park. We thus conclude, for the conditions under which our experiments were performed, that the wind park did not affect substantially wintering eiders. However, many aspects of the potential impact that offshore wind parks may have on sea ducks have not been covered by our study and, therefore, cannot be generalized to other species or other phases of the annual cycle. Nevertheless, we argued that using multiple post-development experiments based on a gradient approach is an helpful complement to BACI studies, especially in situations where there is appearance of no impact.

Characterizing Dispersal Patterns in Marbled Murrelets (Brachyramphus Marmoratus) Using Microsatellites

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The movement of Marbled Murrelets (Brachyramphus marmoratus) among populations is poorly understood due to difficulties in recapturing individuals and the limited attachment of radio-transmitters used in tracking studies. The use of genetic data in combination with morphological information for individual birds may help scientists better understand Marbled Murrelet dispersal. We used genetic population assignments for 667 birds, captured from southeast Alaska to central California, to identify migrant birds and examine dispersal patterns. Individual birds were genotyped at 14 microsatellites and assigned to populations using the program STRUCTURE. Two distinct genetic populations were identified: one included birds from southeast Alaska to northern California, and the second included birds from central California. We observed a greater number of migrants in the central California genetic population than in the northern genetic population. In addition, our results indicated that female and juvenile birds had greater dispersal than males and adults. These results support previous demographic work suggesting that dispersal into central California from the larger northern populations may mask Marbled Murrelet population declines in central California.
Beach Bound: A Trans-Boundary Synthesis of Bycatch-Derived Seabird Beachings in the Salish Sea

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Wide-ranging species pose a challenge to conservation, particularly when populations are distributed across political boundaries. Difficulties may arise when mortality events are considered in isolation rather than as components of cumulative mortality resulting from cross-border activity. The Salish Sea, which includes British Columbia and Washington waters, is an important wintering area for seabirds. Pulses of beached seabirds have been reported on both sides of the border for many decades. Necropsies, when conducted, have suggested drowning of otherwise healthy birds, results that point to fishery bycatch, particularly gillnets. This study compared the magnitude and timing of acute seabird beachings with baseline mortality levels and fishing effort. Systematic monitoring of beaches by the Coastal Observation and Seabird Survey Team (COASST) and Bird Studies Canada (BSC) indicated extremely low background rates of seabird deposition (long-term average 0.11 ± 0.07 SD birds/km in WA; 0.96 ± 0.78 birds/km in BC, respectively) on Salish Sea beaches, as compared to acute events across the region (17.8 ± 20.2 birds/km). Gull species comprise the majority of baseline mortalities whereas common murres (Uria aalge) are most abundant during acute events. Mortality pulses occurred during chum and sockeye gillnet fisheries, and were concentrated in Port Madison Bay, WA and Boundary Bay, BC. Despite the fact that the impact of these mortality events on northwest murre populations remains undetermined, proactive implementation of mitigation, including fishing during daylight hours and the use of modified nets, shown to effectively reduce bycatch, should be adopted throughout all fishery sectors and areas.

A Pioneering Marine Protected Area in Peru: The Guano Islands

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The immense foraging opportunities in the rich Humboldt Current attracts millions of seabirds to nest on points and islands off Peru’s shores. The islands and their immediate surroundings are home to endangered seabirds, turtles and marine mammals. The guano that accumulated there drove Peru’s economy for decades, and the guano islands are recognized as part of the nation’s ecological patrimony. Peruvian guano is still a highly prized organic fertilizer in both the US and Europe, and a great example of a sustainable, low-impact natural resource.

Currently, Peru’s network of Guano islands faces a grave threat. ProAbonos, the national guano export business which has managed the islands for the past decade, is about to turn management of the islands back over to the Peruvian government. When that happens, the guards that are currently posted on the islands will leave. Poachers already sneak onto the islands under the cover of night, when they can fill burlap sacks with hundreds of seabirds in just a few hours. The Peruvian government recognizes this problem, has expressed concern, and is considering its options. It is yet unclear where responsibility for this precious resource will fall.

Civil society groups are lobbying for the area’s incorporation into the national system of protected areas, but the time horizon of such actions is long. Not least of the concerns is the administrative hurdle faced in choosing the appropriate agency to lead the area. In this talk, I will present a case study of the biology, planning and politics of a MPA without national precedent.
Pacific Seabirds in DC

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Seabird scientists play a particularly important role in seabird policy, because fewer other people see and care about seabirds. The recent passage of the Magnuson Stevens Reauthorization with specific language for seabirds, the proposed accession by the US to the Agreement on the Conservation of Albatrosses and Petrels, the funding of the Marine Debris Research and Reduction Act, the attention to Lead contamination on Midway Atoll, and the imminent passage of the Peruvian and other Free Trade Agreements are pertinent policy issues for pacific seabirds. Scientists and science have played a role in each of these, and each initiative poses yet more opportunities for future engagement.

†Catching the Uncatchable Fish: Using Seabirds to Establish Baseline Data about a Key Prey Species, Arctic Cod

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Arctic Cod are a key prey to many marine mammals and are difficult for scientists to collect. Some seabirds can be a viable cost-effective method for acquiring samples of their marine prey. My analysis yielded significant relationships between fork length and dry energy density (DryEDkJ/g = 0.044(forklengthmm) + 16.933, r² = 0.736, n = 12, p<0.0001) and wet mass (WetEDkJ/g = 0.0304(forklengthmm) - 0.1638, r² = 0.848, n = 11, p < 0.0001), which suggest that researchers can gain valuable information about this crucial prey item using only a ruler. My work in the western Beaufort Sea suggest that energy densities of cod are notably lower there than those from the eastern Nuvuk Islands and the eastern Bering Sea, although the sample sizes from both studies are notably small and size information is very poor. Western Beaufort Arctic Cod have a higher dry energy density than all but one of the sampled forage fish species in the north Pacific. The exception was myctophids (Lanternfish), which were not observed as prey on Cooper Island in 2005 or 2006. This work represents a significant addition by the establishment of baseline values of a key prey species.
Smarter than Satellites: Small Ice Floes as Key Seabird Foraging Habitat

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The ice edge is essential habitat for a wide variety of marine predators (and obviously their prey) including at least 12 species of seabirds and seven species of marine mammals such as whales and seals. I developed a protocol to produce information on low-density ice-covered habitat at a biologically relevant spatial scale from free, easily accessed satellite images. To ground-truth the relevance of these small, “subpixel” ice floes as habitat for Arctic Cod and other marine predators, a boat trip was taken to two subpixel ice floes. Plankton tows were performed (0 - 2 m depth) with a plankton net (5 mm² mesh) to quantify the presence/absence of various zooplankton species. The at-ice observations revealed that Black Guillemots (n = 1 - 7) were present at subpixel ice floes. Most of the birds (57 %) observed at the ice floe were diving. Dive duration ranged from 38 - 47 s, which are generally regarded as feeding dives. Out of the eight dives observed, guillemots surfaced twice with Arctic Cod. The ability to identify ice that is visible in a transformed image (such as a band ratio), which is hidden in the original true-color composites, is essential to this work. My masked band ratio technique revealed the presence of daily fine-scale ice where it was not detected using standard visualization techniques. The detection of small (< 250 m²) ice floes extending away from the edge of the pack ice toward the shore is important as it reveals important habitat for ice edge animals that would be overlooked using only true-color composites.

Genetic Variability of Two Sympatric Gull Species, the Black-Tailed Gull and the Slaty-Backed Gull, Inferred from Mitochondrial DNA Control Region Sequences

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Two gull species, the black-tailed gull (Larus crassirostris) and the slaty-backed gull (Larus schistisagus), endemic to the Far East are sympatric in the Hokkaido Island, Japan, although the distribution range extends to south in the former and north in the latter. To examine their genetic variation and population structure, a 438 bp portion of the 5’ mitochondrial DNA control region was sequenced in 286 black-tailed gulls from six breeding colonies and 142 slaty-backed gulls from four breeding colonies. The black-tailed gull showed a total of 23 haplotypes with a low haplotype diversity and a ‘star-like’ genealogy on a parsimony network, while the slaty-backed gull exhibited an increased haplotype diversity and widely stretched haplotype genealogy. Effective female population size estimated for the black-tailed gull, being much smaller than the current census size of this species, was smaller than that of the slaty-backed gull. However, expansion coefficient, Tajima’s D value for neutrality test, and the mismatch distribution analysis suggested that only the black-tailed gull have experienced population size expansion probably after recent bottlenecking. In addition, AMOVA showed most variation occurring within populations and no clear geographic structure in both species. Thus, the observed difference in the genetic diversities between two gull species likely reflected their different historical population demography, possibly influenced by the different ecological characters, such as coloniality, in both species.
Current Information on the Diet of the Kittlitz's Murrelet

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The Kittlitz’s Murrelet (Brachyramphus brevirostris) is a poorly understood seabird endemic to coastal Alaska and eastern Russia. Recent surveys suggest that this species has declined sharply (up to 18% per year) and ubiquitously across their range. High adult mortality and very low reproductive output have been identified as possible proximate causes of decline, while speculated ultimate causes include oil pollution, gill-net mortality, and reduced availability of preferred forage fish. The availability of energetically suitable prey has been linked to declines in other seabirds and may contribute to the observed trend in Kittlitz’s Murrelets. They are marine foragers, generally feeding on small pelagic schooling fish or invertebrates near the outflows of tidewater glaciers or glacial streams. We summarized what is currently known about the diet of the Kittlitz’s Murrelet through literature review, vouchered museum specimens, field notes, unpublished reports, and available data of fish-holders observed at sea. Most of these useful data have remained buried, but when summarized in whole represent a significant amount of information on the diet of this declining seabird. Available data strongly suggest that Capelin (Mallotus villosus) is the principal prey species during reproduction, yet there is very little information regarding non-breeding diet. We identify gaps in knowledge and conclude by investigating the value of new methods for quantifying diet composition, including stable isotope and fatty acid analyses, relevant to the Kittlitz’s Murrelet.

Impact of El Niño on the Seabirds of Protection Island, Washington

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El Niño events, which occur once every two to ten years, are responsible for generating above average sea surface temperatures (SSTs). Higher SSTs result in decreases in zooplankton densities that negatively affect invertebrate and fish populations, and ultimately seabird populations. The impact on seabirds may occur several months following the conclusion of El Niño, given the time it takes for the food energy deficit to work its way through the food web. Counts of marine birds on Protection Island, Washington, were made before, during, and following the 1986-1988 and 1997-1998 El Niño events. Numbers of Pigeon Guillemots, Harlequin Ducks, and loafing Glaucous-winged Gulls were lower during and after these events than before. Data on hatching success in Glaucous-winged Gulls were collected during the 2006-2007 El Niño event. Hatching success was significantly lower in 2007 than in 2006 due to a 59% rise in egg loss. Egg loss was largely attributable to cannibalism. The tendency of gulls to prey on the eggs of conspecifics may increase as the result of an El Niño-induced decrease in the availability of other foods.
Going Deep: Common Murres Dive in Sub-0°C Water for Aggregated Slow-Moving Capelin

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When central-place foraging during chick-rearing, Common Murres Uria aalge exhibit flexible behaviour in the face of widely varying prey conditions. At times this flexibility involves major changes in foraging behaviour and effort. Here we report on deep (≥ 50 m) diving by parental murres foraging from two large Newfoundland colonies (n=9 birds). 21% (n=272) of recorded dives exceeded 50 m, ranging in depth from 50 – 152 m and lasting 82 - 210 sec. Deep dives, which likely involved anaerobic metabolism, took the murres into the cold intermediate layer (CIL 40 – 180 m; defined as < 0°C water) of the Labrador Current. These activities and circumstances involved trade-offs for both the birds and their main prey, female capelin Mallotus villosus. Apparently able to hunt visually in the blue-green spectrum, the murres encountered persistent (predictable) aggregations of capelin. Frigid water in the CIL inhibits the muscle-contractions that capelin need for burst/escape speeds, hence likely making the energy-demanding dives profitable for the murres. So, murres may routinely exceed aerobic dive limits when the uncertainty of prey capture is reduced. From the capelin’s perspective, occupying sub-0°C water may allow avoidance of their major predator, cod Gadus morhua, but they remain vulnerable to deep diving avian and mammalian predators. We discuss how oceanographic influences shape predator prey interactions and trade-offs.

Macroecological Patterns in North Pacific Ecosystem Dynamics: Spatio-Temporal Co-Variation in Upper and Lower Trophic Level Diversity and Productivity from Canada to Japan

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Understanding the mechanisms that structure communities and influence biodiversity are fundamental goals of ecology. To test the hypothesis that the abundance and diversity of upper-trophic level predators (seabirds) is related to the underlying abundance and diversity of their prey (zooplankton) and ecosystem-wide energy availability (primary production), we initiated a monitoring program in 2002 that jointly and repeatedly surveyed seabird and zooplankton populations across a 7,500 km British Columbia-Bering Sea-Japan transect. Seabird distributions were recorded by a single observer (MH) using a strip-width technique, mesozooplankton samples were collected with a Continuous Plankton Recorder, and primary production levels were derived using the appropriate satellite parameters and the Vertically Generalized Production Model (Behrenfeld and Falkowski 1997). Each trophic level showed clear spatio-temporal patterns over the course of the study. The strongest relationship between seabird abundance and diversity and the lower trophic levels was observed in June/July (‘summer’) and significant relationships were also found through March/April (‘spring’). No discernable relationships were observed during the September/October (‘fall’) months. Overall, mesozooplankton abundance and biomass explained the dominant portion of seabird abundance and diversity indices (richness, diversity (Simpson’s Index), and evenness), while primary production was related to seabird diversity. These findings underscore the notion that perturbations of ocean productivity and lower trophic level ecosystem constituents influenced by climate change, such as shifts in timing (phenology) and synchronicity (match-mismatch), could impart far-reaching consequences throughout the marine food web.
Isla Guadalupe’s Goonies: Consequences of Range Expansion for a Pelagic Top Consumer, the Laysan Albatross (*Phoebastia immutabilis*)

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We examine the consequences of a 4000 km breeding range expansion by the Laysan albatross (*Phoebastia immutabilis*) from the pelagic waters of the Hawaiian Islands to Guadalupe Island, MX, in the California Current System. We use electronic tracking tools and stable isotopes to quantify differences in movement patterns and foraging ecology in this marine top consumer at source breeding colonies on Tern Island, HI in the central Pacific and new eastern Pacific breeding colonies on Guadalupe Island. Range expansion has significantly altered albatross population area utilization distributions. Tern birds foraged along the North Pacific Convergence Zone and Guadalupe birds demonstrated near complete spatial segregation, foraging along the California Current during the breeding season. Birds from the new Guadalupe colony had significantly smaller ranges, traveled shorter distances, and spent less time at sea than Tern birds during incubation foraging trips. Individuals from these populations also showed spatial divergence during the non-breeding season, where Guadalupe birds ranged further from the colony and preferred more eastern regions of the North Pacific Ocean. Mean whole blood δ¹³C and δ¹⁵N values of tracked birds were significantly higher in Guadalupe birds (1.4‰ and 3.4‰ higher respectively) indicating that Guadalupe birds feed a full trophic level higher than Hawaiian birds. We suspect these ecological variables are in part responsible for documented differences in population trajectories between the new Guadalupe and source Hawaiian colonies.

Matches and Mismatches in the Breeding of a Mainly Zooplanktivorous Seabird, Cassin's Auklet

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The central tenet of the match-mismatch hypothesis is that predators breed more successfully in years in which there is a greater temporal overlap between their breeding cycle and the period of maximal availability of key prey species. The hypothesis is frequently invoked as a mechanism linking oceanographic conditions to seabird breeding success. I tested predictions of the match-mismatch hypothesis developed for Cassin’s Auklets *Ptychoramphus aleuticus* breeding at Triangle Island, British Columbia, and relying heavily on the copepod *Neocalanus cristatus* as prey for chicks. The two main predictions of the hypothesis were supported: *N. cristatus* persisted longer in auklet chick diets - suggesting greater temporal overlap - during colder, higher productivity years (1999-2002) than during warmer, lower productivity years (1996-1998 and 2003-2006). In addition, Cassin’s Auklets chicks grew more quickly in years when they received more copepods in their diets. However, contrary to prediction, the main effect of oceanographic conditions (SST as proxy) on breeding success operated outside of the SST-*N. cristatus* loop. Thus, it appears that oceanic conditions that influence or reflect productivity, rather than strong temporal matching with a single key prey species, is the most important factor explaining variation in breeding success in this zooplanktivorous species.
In Search of the Elusive Townsend’s Shearwater

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The Townsend’s Shearwater (Puffinus auricularis) is a critically endangered Mexican endemic, presently breeding only on Socorro Island in the Revillagigedo Archipelago. Despite its status, the species is virtually unstudied on its breeding grounds. In this preliminary study of the breeding population, we assessed its spatial distribution and habitat characteristics in breeding areas. We conducted 20 sets of parallel transects, ranging from 300-1000m in length, in areas that previous observations indicated had shearwater activity. On each transect, we searched for burrows and geo-referenced the following habitat variables: elevation, slope, plant coverage and plant species composition. Thirty burrows but no colonies were found. Instead, burrow locations were patchy (6 of 20 transects) and sparsely distributed (mean=0.0008 ± 0.0004 burrows/m²). We encountered only two burrow clusters (2+ entrances within 3m radius), comprised of two and three burrows. Surveyed areas ranged from 680-1040m above sea level, with burrows found in a narrow elevational range of 857-950m (mean=895 ± 26m). All burrows were found on vegetated slopes (mean=22° ± 8°) with 76-100% plant cover. We expected to find colonies in areas of previous shearwater aerial activity, but we instead found highly dispersed burrows across the landscape. These initial results suggest that either (1) our survey coverage did not overlap with the central breeding area(s) or (2) the species is not truly colonial. If the latter interpretation is correct, the population may be considerably smaller than previously thought. In both cases, shearwaters are vulnerable to predation by feral cats and habitat degradation by feral sheep.

More than Just a Cute PSG Logo: Tufted Puffin Population Status in Washington

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Tufted Puffin (Fratercula cirrhata) populations have apparently declined significantly in Washington State waters during the 1980s and 1990s. However, quantitative assessments of factors influencing puffin population trends are lacking. To begin to evaluate population trends and potential explanatory factors, we have monitored the puffin population on Tatoosh Island, Washington since 2005, compared breeding performance to that of sympatric seabird species and used boat-based surveys to assess occupancy of historic breeding sites. On Tatoosh Island, we used counts of birds on the water, in flight and on the colony surface as abundance metrics. Attendance patterns varied intra-seasonally and interannually. The percentage of active burrows on Tatoosh was consistently high, ranging from 72-84%. Hatching success was more variable (range: 56-82%), with 2007 being significantly lower than the preceding two years. Fledging success was generally low, with only 2006 exceeding 40%. In 2007, boat-based surveys indicated that 8 of 21 historically occupied breeding sites in Washington were no longer active (38% reduction). Additionally, these surveys found a lack of colony attendance in August, consistent with concurrent low on-water and on-colony counts at Tatoosh. This apparent premature abandonment suggests a possible widespread breeding failure in the Washington population during 2007. Overall poor puffin reproductive success contrasts strongly with contemporaneous studies of Rhinoceros Auklets (Cerorhinca monocerata), which had high levels of hatching (range: 76-90%) and fledging success (range: 65-81%) during the same three-year period. These results imply that Tufted Puffins may be particularly sensitive to factors such as bottom-up changes and/or on-colony disturbance.
Landscape-Level Associations of Marbled Murrelet Inland Activity in Old-Growth Forests within a Commercial Forest Landscape

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Washington Department of Natural Resources (DNR) manages 110,000 ha of state forests on the western Olympic Peninsula for conservation and commercial objectives. These forests support widespread inland activity of the threatened, forest-nesting Marbled Murrelet (Brachyramphus marmoratus). I examined how the intensity and extent of this activity covaried with landscape composition and pattern. Inland surveys in DNR-managed old-growth forests (16,000 ha) provided continuous probability density functions of marbled murrelet activity at 3 spatial scales: 13, 50, and 95 ha representing competing hypotheses regarding the scale of murrelet responses. I developed 55 models that reflected hypotheses about murrelet responses to the characteristics and abundance of late-seral forests, abundance of interior forests, abundance of high-contrast edges, and compositional diversity of surrounding landscapes. Cell-based modeling related murrelet activity to landscape characteristics indexed at multiple scales (200-1,600 m), models were judged by fit and parsimony. I evaluated the hypothesis that murrelets exhibited time-delayed responses to fragmentation by adding early-seral forest covariates to the best of those models. Murrelets responded to landscapes at the 50-ha scale. Activity increased with the density of old-growth and other late-seral forests at the 200-m and 400-m scales respectively, without influence from the broader-scale abundance of late-seral forests. Activity increased with edge-contrast and early-seral forests in the presence of locally abundant late-seral forests. These findings suggest marbled murrelets can tolerate substantial fragmentation and that habitat management at relatively fine scales may provide conservation benefits. Knowledge of population responses to nesting in potentially risky, fragmented habitat can help improve marbled murrelet conservation.

†Is Avian Predation on Snake River Salmonid Smolts Additive or Compensatory Mortality?

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In 2007 we conducted a pilot study to assess whether mortality from avian predation on ESA-listed salmonids (Oncorhynchus spp.) from the Columbia River Basin is compensatory or additive. Avian predation on juvenile salmonids can only limit recovery of ESA-listed stocks if the mortality is at least partly additive. We PIT-tagged, condition scored and released 7,089 steelhead (O. mykiss) smolts at Lower Monumental and Ice Harbor Dams on the Snake River and used detections of these fish to determine susceptibility to avian predation and survival of steelhead smolts through the Columbia River hydrosystem. Surveys detected 439 PIT tags from this study (6.2%) on colonial waterbird nesting islands in the Columbia River above McNary Dam. Of these tags, 215 (49.0%) were from a Caspian Tern (Hydroprogne caspia) colony, 139 (31.7%) from a Double-crested Cormorant (Phalacrocorax auritus) colony, 51 (11.6%) from a gull (Larus spp.) colony, 21 (4.8%) from an American White Pelican (Pelecanus erythrorhynchos) colony and 13 (3.0%) from an area used by roosting terns and gulls. Results indicated that smolts exhibiting severe external damage (n=1,023) were 1.7 times more likely to be consumed by avian predators in the McNary Pool compared to moderately or undamaged smolts (n=6,066). Only 0.39% (n=4) of PIT-tagged steelhead exhibiting severe damage were detected at Bonneville Dam compared to 1.07% (n=65) moderately or undamaged smolts. These results suggest that smolt mortality due to avian predators on the mid-Columbia is partly compensatory, and not all avian predation mortality is additive.
Seabirds, Habitat and Economic Culture: The Global Link and the Evidence

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The devastating state of the ocean's habitats is widely known and published. Most flora and fauna is affected by humans; they reflect the way humans operate the world. Economic growth is part of most nations' policies to maximize short-term gain. This culture also affects our seabird populations. Undisturbed ocean wilderness areas hardly exist anymore, and thus, seabirds are frequently exposed to human stressors. Studies of toxicology, habitat fragmentation, and the advent of climate change, have made that very clear, but many of these and related issues are not well studied for seabirds. From over 10 years of fieldwork and studies, I present examples of how economic culture affects selected components of seabirds and their habitats in the Sea of Okhotsk, Alaskan and British Columbian waters, the South East Pacific, Northwest Atlantic, West Africa and the North Sea. Further, I present what metrics are suitable for expressing this situation biologically (e.g. number endangered species and reliable trends), and what type of statistically sound monitoring data we still need to collect to better assess the true impacts of human activities on global sustainability of the oceans and beyond.

Arctic Ocean Diversity (ArcOD), a Census of Marine Life Project: The Need for Public Arctic Data Related to Seabirds and Beyond

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The Arctic Ocean Diversity Project of the Census of Marine Life (http://www.coml.org/ descrip/aobio.htm) is an international collaborative effort to inventory biodiversity in the Arctic’s sea ice, water column and sea floor from the shallow shelves to the deep basins. It employs a three-layer approach: compilation of existing data, modern taxonomic identification of existing samples, and new collections focusing on taxonomic and regional gaps. ArcOD contributes to OBIS (Ocean Biogeographic Information System; www.iobis.org/), and is housed within the School of Fisheries and Ocean Sciences, Institute of Marine Sciences at the University of Alaska Fairbanks, USA. Russian partner centers are located at the Zoological Institute in St. Petersburg and at the Shirshov Institute of Oceanology in Moscow, Russia. ArcOD was formed in 2004, and is part of the CoML/ OBIS scheme until at least 2010. ArcOD data cover the entire biological diversity of the circumpolar Arctic including seabirds using high quality Darwin Core data and FGDC NBII metadata standards. Here, we will present on existing ArcOD data (100,000 new records from over 30 datasets and 2500 cumulative species) and make a call for circumpolar data related to seabirds in order to fill this crucial information gap for improved assessment of Arctic biodiversity.
Boat-Based Distance Sampling in the Sea of Okhotsk to Quantify the Coastal Wilderness Biodiversity of the Vostochny Zakaznik, Sakhalin Island, Russian Far East

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The Vostochny Zakaznik is one of the last remaining Wilderness Areas in the entire Pacific Rim. It is located on the eastern side of Sakhalin Island in Russian Far East facing the Sea of Okhtosk. This watershed is still relatively intact hosting a complete Pacific coastal community including old-growth forests, bears, several salmon species, seals, sea lion rookeries, whales, seabirds and many other species in high abundance. Specific aspects of this unique terrestrial system have already received a first biodiversity inventory, whereas the precious marine section still lacks quantified investigations. Here, we show first quantitative estimates for marine wildlife obtained during August 2007 using boat-based Distance Sampling. We were able to capture the marine biodiversity as absolute abundance (densities corrected for detectabilities) and with statistical confidence intervals. Our surveys found Albatross, gulls, auks and seals often concentrated at estuaries and fishing activities. Of specific interest are Long-billed Murrelet sightings quantified for the first time, and indicating that this rare bird nests in the adjacent old-growth forests. Considering climate change, additional man-made stressors (e.g. poaching and oil pollution) and the unique natural resources of this refuge, we suggest to further increase the protective status and its enforcement for this globally unique watershed.

Behavioural Mechanism of Biased Food Allocation within a Brood in Japanese Comorant

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Begging behavior of chicks may affect behaviour of siblings as well as that of parents. In the year of poor food availability seabird parents may concentrate their provisioning on the dominant chicks, while subordinate chicks may adjust the begging behaviour according to those of dominants. Parents of Japanese cormorants (Phalacrocorax capillatus) feed chicks several times after they come back from each foraging trip. So timing of begging across these multiple feeding events may be important for food acquisition of subordinate chicks. We examined if there was a bias of food allocation among siblings in years of different food availability and if subordinate chicks did best in the worst status by regulating the timing of begging. The study was carried out in middle of June in 2005 and 2006 at Teuri Island, northwest of Hokkaido. We used 8 nests, of which brood sizes are three. After the chicks were weighed, measured and individually identified, we observed feeding and begging behaviour. Overall chick survival was greater in 2006 than in 2005. In both years, dominant chicks had a priority in the access to the meals. There was no evidence for the regulation of begging timing by subordinate chicks in response to those of dominants in both years. In 2006, subordinate chicks had a chance to gain food after dominants were satisfied. In 2005, however, subordinates received less food than dominants. This resulted greater growth and survival of dominant chicks than subordinate siblings in this year with presumably poor food availability.
Seabird Databases on the Web Now and in the Future

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The North Pacific Seabird Colony Database is currently on the web and is interactive; maps and data can be downloaded. The Pacific Seabird Monitoring Database is on the web, but is not interactive; maps and reports can be downloaded. To access these databases go to Google and type in the name. The Pacific Seabird Monitoring Database is currently on the web and is interactive; maps and data can be downloaded. The North Pacific Pelagic Seabird Database is on the web, but is not interactive; maps and reports can be downloaded. To access these databases go to Google and type in the name. The North Pacific Seabird Diet Database has been funded and plans are to have it on the web and make it interactive. The Seabird Information Network has been partially funded and work is progressing. With the upcoming World Seabird Conference it is planned that a World Seabird Colony Database will be one of the products of the meeting.

Prey Selection and Foraging Behaviour during Self-Feeding and Chick-Provisioning in Thick-Billed Murres (Uria lomvia)

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Parent birds are hypothesized to maximize both of the provisioning rate for their chicks and the feeding rate for their own energy demand. This is challenging especially for seabird parents, as they forage over the vast of ocean far from their breeding colony. In Thick-billed Murres, we recorded their foraging behavior using small (3 g) depth-temperature data loggers, on St. George Island, Bering Sea, July-August, 2006 and 2007, to investigate how parents adjust their prey selection and foraging behavior. Prey types and its size for both chicks and parents themselves were investigated by observation of chick meal and analysis of stomach contents sampled by water offloading technique. Parents delivered larger prey items (e.g. larger pollock) for their chicks while they fed on smaller prey items (e.g. smaller pollock and krill) for themselves. Parents dived deeper during the last dive bout of foraging trip (presumably for chick-provisioning) compared to the rest of dive bouts (presumably for self-feeding). It may be necessary for murres, i.e. single prey loaders, to select larger prey to maximize provisioning rate, because distance to foraging area, hence trip duration, is long. The differences in dive depths between self-feeding dives and chick-provisioning dives appeared to correspond to the distributions of small pollock and krill (shallow, around thermocline depth) and of larger pollock (deeper than thermocline depth) around St. George Island. Thus parents seemed to maximize chick-provisioning rate and self-feeding rate by adopting two types of diving behaviour to feed on different types of prey within foraging trip.
Diet Quality, Body Condition, and Breeding Chronology of Marbled Murrelets (Brachyramphus marmoratus) within the Georgia Basin

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The Marbled Murrelet (Brachyramphus marmoratus) is a small, threatened seabird that nests in old-growth forest and forages year-round in near-shore waters of the Northeast Pacific. Previous research has demonstrated correlations between historic trophic feeding level and breeding success, but whether trophic feeding level is causally linked to breeding success and what the mechanisms behind this relationship are, remain unknown. We captured 212 murrelets during the 2006 and 2007 breeding periods in Desolation Sound, British Columbia, to test the hypothesis that pre-breeding trophic feeding level is positively associated with timing of breeding. We used stable-carbon and –nitrogen isotopes from feathers and blood of captured murrelets to determine trophic feeding level, and a plasma protein to assess breeding condition of females. We found that early in the breeding season, murrelets in breeding condition fed at lower pre-breeding trophic level than murrelets who were not in breeding condition, indicating a relationship between timing of breeding and diet quality. This study is one of the first to identify a potential mechanism by which diet quality influences breeding success. Our results suggest that conservation of the Marbled Murrelet within the Georgia Basin should focus on maintaining the integrity of marine, as well as terrestrial habitats.

Breeding Ecology of Kittlitz’s Murrelets at Agattu Island, Aleutian Archipelago, Alaska

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Nest site selection, chick growth rates, and reproductive success of Kittlitz’s Murrelets (Brachyramphus breverostris) was studied at Agattu Island, Alaska. Kittlitz’s Murrelets are a poorly known seabird and this study provides some of the first reproductive data for this species. Nest survival for the one egg, ground nests of Kittlitz’s Murrelets was low during the 30 d incubation period (0.26 ± 0.1), most likely due to avian predators locating unattended eggs. Survival during the 30 d nestling period was also low (0.18 ± 0.2), with 75% of chick mortalities due to inclement weather. Nest site selection of the ground nest may be influenced by site-specific characteristics rather than general habitat characteristics, with orange crustose lichens being a potential point of selection rather than general topographical features. Growth rates of Kittlitz’s Murrelet young are lower than all other alcids (KL = 0.04 - 0.10), with chicks departing from nests at 45% of adult mass. Our findings confirm that Kittlitz’s Murrelets breed in the west Aleutians and have low reproductive success similar to their congener the Marbled Murrelet (B. marmoratus).
Sailing the Seas of Change?: Interannual Variability in Oceanographic Habitat Use by Hawaiian Albatrosses

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We studied the foraging behavior and oceanographic habitat use of Laysan (Phoebastria immutabilis) and black-footed albatrosses (P. nigripes) on Tern Island, Northwest Hawaiian Islands, during four consecutive breeding seasons to investigate whether these species change habitat preferences, foraging distributions, or both, in accordance with natural interannual variability in the marine environment. We used satellite telemetry to track a total of 37 Laysan and 36 black-footed albatrosses during the incubation periods of 2002-03, 2003-04, 2004-05, and 2005-06. First passage time analysis was utilized to determine areas where individual albatrosses increased search effort along their tracks, and related to oceanographic habitat parameters using linear mixed-effects regression. The majority of individuals tracked in this study traveled to pelagic waters of the North Pacific, with Laysan albatrosses demonstrating a more northwesterly distribution. Laysan albatrosses traveled further, for longer periods, and covered more total distance than black-footed albatrosses. Laysan albatrosses demonstrated interannual differences in maximum distance traveled from the colony, total distance traveled, trip duration, and transit rates, while black-footed albatrosses demonstrated interannual differences in transit rates, moderate evidence of interannual variation in trip duration, and no interannual variation in distances traveled. Best-fitting oceanographic habitat models differed both between species and year, suggesting that each species demonstrated plasticity in both foraging behavior and habitat preferences. A functional understanding of how changes in the marine environment affect albatross foraging behavior and habitat use can provide insight into how future environmental perturbations, such as global climate change, are likely to affect these populations.

A Fine-Scale Time Budget of Chick-Rearing Streaked Shearwaters Calonectris leucomelas during Foraging Trips

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Developments in satellite telemetry have provided horizontal migration route of seabirds. However there is little information on fine-scale time budget during their foraging trips, because of difficulty to monitor the same individual. This information is an important issue to complete our basic knowledge of life history in seabirds. A recently developed miniaturized acceleration data logger now makes such measurements possible. We monitored the flight behaviors of Streaked shearwaters (Calonectris leucomelas) using the data logger (M4-D2GT, 60×15mm, 18g; Little Leonardo Co., Tokyo, Japan) to reconstruct the time budget. The devices simultaneously recorded depth and temperature (1 Hz) and acceleration (16 Hz) along two axes. The life of battery was 64 hours. Field study was conducted at breeding colony (39°18’ N, 141°58’ E) on Sangan Island, Iwate Prefecture, Japan in September, 2006-2007. Loggers were attached to sixteen birds on their belly to record surging acceleration along the longitudinal body axis of birds and heaving acceleration dorsoventrally. They spent 87.2 ± 4.7% (range 75.8- 90.5%) of the foraging trip (49.3 ± 17.3 h; range 14.6-60.2 h) in flight, using flap-glide flight, and gliding 10 to 90% of the flight. Each flight time ranged variously from a few seconds to several hours. The gliding ratio increased (more than 60%) as the flight time increased. Birds performed on average 1.1 ± 1.2 dives/ day (more than 1m; range 0- 4 times). These results suggest that they achieved long flight by increasing the glide time, and mainly foraged at the sea surface.
†Inter Colony Differences in Breeding Responses of Black-Tailed Gull (Larus crassirostris) to Annual Variations of Pelagic Fish Availability at Local Scale

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Breeding seabirds are believed to be good indicator of prey availability within their foraging area. So the study of breeding responses of single seabird species to variations of marine environment at different colony may reveal differences in variations of prey availability and ecological processes at local scale. Prey species and growth rates of chicks of Black-tailed Gull at Teuri and Rishiri Island, Hokkaido, Japan, both located in Japan/East Sea and just 90 km apart, were measured from 1998 to 2006, and the effects of sea surface temperature (SST) were analyzed. At both islands, 0+ and >1+ Japanese sand lance (Ammodytes personatus) and Japanese anchovy (Engraulis japonica) were main prey of chicks. At Teuri Island, chicks grew more rapidly in the year with normal June SST than years with low and high June SST and prey species composition did not affect growth rates. At Rishiri, in the year when SST anomalies in July was high, the mass proportion of 0+ sand lance was greater, and chicks grew more rapidly. The results suggest high availability of prey species in years with normal June SST at Teuri, while, and high 0+ sand lance availability in years with high July SST at Rishiri. Key prey species determining the chick growth and the marine environmental factors enhancing the prey availability seem to be different.

Discovering Nests of a Rare Non-Colonial Seabird, the Kittlitz’s Murrelet

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The Kittlitz’s murrelets (Brachyramphus brevirostris) is one of the most secretive seabirds in the world with nearly all aspects of its breeding biology undescribed. Yet this species has been classified as “critically endangered” and listed as “one of the top 10 most endangered birds in the United States”. We captured and attached radio-transmitters to 44 Kittlitz’s murrelets during May 2006-2007 in Icy Bay, Alaska. Mass (g ± SE) of both males and females was notably higher in 2007 (females = 259 ± 17; males = 251 ± 15) compared to birds captured in 2006 (females = 247 ± 15; males = 226 ± 20). Similarly, in 2006 only 43% (6 of 14) of birds had some level of brood patch development, while in 2007 most females (65%; 13 of 20) had brood patch scores >0 and nearly all (94%) had elevated levels of vitellogenin, an egg yolk precursor protein. We conducted 16 (114 locations) and 27 (572 locations) aerial telemetry flights in 2006 and 2007, respectively. In 2006, we did not locate any known or suspected nests, but in 2007 we discovered four active nests. Of these, we were able to visit two nests on the ground. We monitored one nest continually using a remote video camera system, permanently recording incubation exchanges, hatching, and prey deliveries. We visited the other accessible nest on five occasions, but this nest failed probably due to temperature stress. We will present revised estimates of breeding phenology, summary statistics on nest locations, and estimates of reproductive measures. We will also speculate on potential factors limiting population growth of this imperiled species.
New Technology for an Old Friend – Use of GPS Dataloggers for Determining Foraging Strategies of Black-Legged Kittiwakes

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Black-legged Kittiwakes (Rissa tridactyla) are the most abundant gull species in the world but some populations have declined dramatically in recent years. They are surface feeders and thus can compensate for low food availability only by increasing their foraging range or intensifying their foraging effort. Kittiwakes are widely studied in many respects, but long-distance foraging and the limitations of conventional radio telemetry have kept this crucial activity largely out of view. GPS datalogger techniques are improving rapidly and devices are becoming markedly smaller. With these developments it is now possible to use this technology for even smaller birds like Kittiwakes.

Here we present data about the foraging strategies of Black-legged Kittiwakes in the North Pacific. During the breeding season 2007 we placed small (11g) GPS data loggers on 9 Black-legged Kittiwakes breeding on Middleton Island in the Gulf of Alaska.

We obtained data for 16 foraging trips and analyzed foraging areas, range, trip duration, and relationships among those features. Beside one individual, all birds foraged north of the island. Three birds performed foraging trips close to the colony, less than 13 km, while six birds had mean foraging ranges of about 40 km. The maximum foraging range of Black-legged Kittiwakes was 92 km (mean 29 km ± 27 km) and the maximum distance traveled was 240 km (mean 68 km ± 67 km). Distance traveled and maximum distance to the colony were positively correlated with trip duration. The maximum trip duration was 31 h (mean 8 h ± 7 h).

†Time-Depth-Temperature Recorder Reveals First Insights into Diving Behaviour of Tufted Puffins

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Tufted Puffins (Fratercula cirrhata) breed over a broad geographic range from Arctic Alaska to California and the western Chukchi Sea to Japan. This conspicuous species is much admired by the public and seabird researchers alike, but knowledge of some aspects of its biology, especially foraging ecology, remains very limited. For example, information concerning dive depths and dive behaviour is available only from calculations based on body size.

Here we present, for the first time, data on the dive performance of Tufted Puffins obtained by a time-depth-temperature-recorder. During the 2007 breeding season we deployed this device to a chick rearing Tufted Puffin breeding on Middleton Island in the Gulf of Alaska and acquired data over nearly three complete days. The bird performed a maximum of 353 dives per day. Maximum dive depth was 59.7 m (mean 17.3 m ± 14.8 m). The deepest dives occurred between 06:30 and 22:30. Dives were shallower in the early morning and late evening. Dive depth was positively correlated with dive duration (p < 0.01). The maximum dive duration was 3.2 min (mean 1.2 min ± 0.6 min).

Though obtained from a single bird, these data provide interesting first insights into the diving behaviour of Tufted Puffins. The technology holds promise for a much improved understanding of this remarkable species.
Using the Alaska Pelagic Seabird Observer Program to Assist Management of, and Identify Potential, Marine Protected Areas

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Alaska has an array of regulations and marine restricted areas associated with management of its large and diverse fisheries. In addition, in 2006 the NOAA Fisheries Service, upon recommendation of the North Pacific Fisheries Management Council, established the Aleutian Islands Habitat Conservation Area, which covers over 279,000 square nautical miles. While these areas are not currently marine protected areas in the strictest sense, they provide a patchwork of habitats with some degree of protection, usually by fishing gear or timing restrictions. These area restrictions have the potential to benefit Alaska’s seabirds, or alternatively, could increase fishing activity in the open areas with potentially negative impacts on seabirds. For nearshore protected areas such as occur in the Aleutian Islands, the Alaska Seabird Colony Database can be useful. However, for more pelagic areas the Alaska Pelagic Seabird Observer Program, which feeds data into the North Pacific Pelagic Seabird Database, could be one tool to evaluate potential impacts to seabirds of the semi-protected marine areas in Alaska. With support from the North Pacific Research Board, in 2006 the U. S. Fish and Wildlife Service collaborated with NOAA Fisheries and several NSF-funded programs to place seabird observers on research vessels that covered large sampling grids, and this effort will continue through 2010. In 2006-2007 we joined 24 cruises and surveyed >30,000 km of transects, primarily in the Bering Sea. We show broad-scale patterns of distribution that suggest areas and seasonal periods of importance to seabirds. We also identify designated ‘MPA’s’ that lack current information on seabird distribution, particularly in the Gulf of Alaska.

A Geographic Analysis of Caspian Tern Band Encounters in the Americas, 1922-2007

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Band recoveries and field observations of color-banded birds are regularly used to determine the timing and routes for migration, wintering locations, and causes of mortality for waterbirds. We analyzed encounters of 82,454 Caspian Terns (Hydroprogne caspia) banded between 1922 and 2006 (National Bird Banding Lab) originally banded at 118 sites in the U.S. and Canada using geospatial analysis. We found 3,466 band recoveries and another 289 unique color-band encounters of terns judged to be either migrating or wintering. Our analysis revealed two major migratory routes. Birds from the Pacific or Western Region dispersed south to the Pacific coast from southern California to northern Central America and reservoirs and lakes in the central highlands of Mexico. Terns banded in the Great Lakes, Atlantic, and Gulf Coast regions dispersed across the Gulf of Mexico to locations on the coasts of Caribbean islands, the Yucatan Peninsula, and northern South America. These three previously described eastern populations mixed widely between years on the breeding and wintering grounds and we propose these populations be considered a single Eastern Region population. During the winter there were no areas in which terns from the Eastern and Western populations mixed. Because so few terns have been banded in Central Canada and the Great Plains, we could not evaluate the relationship between terns breeding in this portion of the continent with other regions. Limited data from North Dakota and Montana do suggest that Central North America is a region of modest overlap between the two main populations.
Abdominally Implanted Transmitters with Percutaneous Antenna Affect the Dive Performance of Common Eiders

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Implanted transmitters have become an important tool for studying sea duck ecology, but their effects remain largely undocumented. We assessed how abdominally implanted transmitters with percutaneous antenna affect the dive speeds, stroke frequencies, and dive duration of captive Common Eiders (Somateria mollissima). We recorded video of six birds diving 4.9 m prior to surgery to establish baselines, implanted birds with 38-47 g platform transmitting terminals (PTTs), and then recorded additional diving at staggered intervals for 3.5 months to determine effects. Both descent and ascent rates were slower compared to baselines for most investigated days. Descent speeds were 16-25% slower and remained below baselines at the end of the study. Ascent speeds were 15-43% slower for up to two months after implantation. Dive durations were longer than baselines until day 22. Foot stroke frequencies while foraging on the bottom were slower for most measurement days between 15-107 days post-surgery. Foot/wing stroke frequencies during descent were not affected. Researchers that are considering the use of implanted transmitters with percutaneous antennas should be mindful of these effects and the likelihood of concomitant alterations in foraging success, migratory behavior, and possibly even survival compared with unmarked conspecifics. Future research on improved implant procedures and transmitter design are warranted.

†Siblicide and Sexual Conflict between Parents in Black-Legged Kittiwake

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It is well known that the proximate mechanism triggering facultative siblicide (i.e. fatal sibling aggression) is starvation when environmental conditions are poor. However, it remains a puzzle how food can be limiting at a time when hatchlings need only a small quantity of food. One way to solve this puzzle is to postulate that parents anticipate food shortage in tactically providing less food. Our new hypothesis is that parents may also be able to take similar decision in other unfavourable circumstances such as when there is a pair conflict. A bird mated with a bad partner would decrease its effort, hence they would promote siblicide and spare energy for a next breeding with potentially a better mate. To test this new hypothesis in Black-legged kittiwake (Rissa tridactyla), we handicapped some males by decreasing their wing area at the beginning of the chick-rearing period. Neither the handicapped males nor their partner lose significantly more weight than the control birds. Both parents tend to decrease their feeding rate. Their chicks grow significantly more slowly, they are more aggressive and suffer more mortality. As it is expected in long-lived birds, we show that males with experimentally increased reproductive effort pass the cost to their offspring. Females seem to adjust their effort to the quality of their mate which leads to siblicide when they are mated with a bad partner. Our study is the first to demonstrate that siblicide may occur in a context of sexual conflict.
The Importance of Herring Spawn for Spring Migrating Surf Scoters (Melanitta perspicillata): Do they Ride a “Silver Wave” North?

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We used satellite telemetry to consider the timing of spring migration of surf scoters (Melanitta perspicillata) relative to the timing of Pacific herring (Clupea pallasi) spawn initiation on a continental scale. Also, within Southeast Alaska, we contrasted habitat attributes of stopover sites to those of random sites to evaluate the importance of herring spawn relative to other landscape features. We found a general correspondence in phenomenology of scoter migration and herring spawn activity, in support of the “silver wave” hypothesis that scoters are timing their spring migration to take advantage of this ephemeral but abundant food resource. In Southeast Alaska, we identified 14 important stopover sites using locations from satellite transmitter-marked surf scoters from 2003-2006. Using an information-theoretic model selection approach, we found that habitat attributes of these sites differed from unused sites with respect to the distance to Pacific herring spawn sites and the distance to the outer coast, while physical shoreline attributes were generally poor predictors of site use. Stopover sites were closely associated with herring spawn sites and were concentrated along the mainland coast. One site, Lynn Canal, was identified as being an exceptionally important stopover and staging site for surf scoters from across their Pacific winter range; roughly half of the coastally-migrating surf scoters used this area, many for extended periods. We conclude that the geographical context and resource availability within Southeast Alaska, specifically herring spawn, provides unique and potentially critical stopover habitat for spring migrating surf scoters.

Spatial Relations between Foraging Auklets, Zooplankton, Primary Production, and Converging Water Masses in the Northern Bering Sea

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Millions of Least and Crested Auklets (Aethia pusilla, A. cristatella) breed and forage on the Bering Sea shelf north of St. Lawrence Island. Chick diets are mostly krill and Neocalanus copepods which reproduce off the shelf and are advected hundreds of kilometers to this region by the Anadyr Current. Auklet nesting chronology and reproductive success are strongly related to spatial accessibility of these zooplankton, as influenced by the relative positions of Anadyr, Bering Shelf, and Alaska Coastal waters which converge before flowing through Bering Strait. From 29 May to 5 June 2007, these auklets fed mainly in two apparent frontal regions: between Anadyr and Bering Shelf waters to the southwest, and to the northeast where the three water bodies converge south of Bering Strait. Preliminary counts of total zooplankton densities averaged almost 3 times higher in areas of high auklet numbers. Winds that determine the strength, temperature, salinity, and convergence locations of these flows also mediate the extent and timing of ice cover, thereby linking changes in patterns of sea ice to later foraging distributions and breeding success of planktivorous auklets.
Trends in Avian Predation on Juvenile Salmonids in the Columbia River Estuary: Buffering by Marine Forage Fish

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Marine forage fish may serve as an important buffer against predation on juvenile salmonids (Oncorhynchus spp.) during the estuarine and early ocean period. We examined the diet of Columbia River Estuary Caspian Terns (Hydroprogne caspia), during 1997-2006, to identify which marine species are important alternative prey and to identify when marine species replace salmonids in the tern diet. In years of low availability of marine forage fish (e.g., 1997-1998), terns relied on salmonids for a majority (~3/4) of their diet throughout their nesting period (April – July). As marine forage fish abundance increased following the 1998 El Nino event, salmonids have been the most prominent prey type only during the peak out-migration period (May and early June). Following the peak of the out-migration, Northern Anchovies (Engraulis mordax) generally replace salmonids as the most prominent prey type, although Pacific Herring (Clupea pallasii) and Shiner Surfperch (Cymatogaster aggregata) are important alternative prey in some years. Years of strong tern reliance on anchovy or herring are not particularly well predicted by Columbia River Plume research cruises (Emmett 2006) or commercial landings data, perhaps due to differences in age classes caught by estuarine terns and ocean seining efforts. In April and early May, prior to the annual peak of smolt out-migration, Surf Smelt (Hypomesus pretiosus) and in some years Pacific Sardine (Sardinops sagax) are important components of the tern diet. Strong sardine year classes may effectively reduce avian predation on early out-migrating smolts in some years (e.g., 2001, 2004-5).

Colony Attendance and Audio Cue Use by Prospecting Ancient Murrelets at Langara Island, BC in 2007

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Prospecting individuals need to locate, attend, and assess a number of potential colony sites prior to making a decision of where they will settle to breed in the following year. Therefore, factors affecting prospector colony attendance will be different than those affecting breeder colony attendance. Specifically, nocturnal burrow-nesting seabird prospectors require the presence of conspecific vocalizations as an indicator of the presence of a breeding colony, along with fair environmental conditions (calm wind and waves, and dark evening). I hypothesize that prospecting Ancient Murrelets (Synthliboramphus antiquus) will attend potential breeding colonies only when conspecific vocalizations are present and during fair environmental conditions. To identify whether environmental conditions affect prospector colony attendance I used an information theoretic approach to identify the most parsimonious models for prospector colony attendance at McPherson Point (active colony site where vocalizations are always present during the breeding season). The most strongly supported models included weather at the colony and at the foraging grounds, and light conditions. Using the most parsimonious models from McPherson Point in a second information theoretic framework, I tested whether the presence of vocalizations affect prospector colony attendance at abandoned colony sites (where vocalizations are only present during call playback trials). In this case, the most strongly supported model included only the call playback term, however models that included colony weather and light conditions also received strong support. This analysis supports the prediction that nocturnal burrow-nesting seabirds require the presence of conspecific vocalizations in order to locate potential breeding sites.
Implementation of a Rat Prevention Database on St. George Island

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The Pribilof Islands host one of the world’s greatest concentrations of marine wildlife including approximately 3 million nesting seabirds. If rats are introduced they will likely decimate most of the bird life. Following the construction of commercial harbor facilities on the islands, the communities of St. Paul and St. George, in cooperation with the Alaska Maritime Wildlife Refuge, established a rat prevention program. To date rat prevention has been successful with six rats killed since the program began. To further enhance this effort, the St. George Kayumixtax Eco-Office, in collaboration with the Aleut Community of St. Paul Ecosystem Conservation Office and the AMNWR has established a computerized database for documenting rat station activity and maintenance, and analyzing effectiveness of defences. The database is designed to: 1) allow staff the ability to enter standardized station maintenance information into handheld computers with integrated GPS for ease of use in the field and direct data transfer to desktop database, and 2) allow supervisors quick review of maintenance records and the ability to analyze station placement geographically to maximize efficiency of station location and response capability. Spatial data for rat stations are analyzed to look for gaps in coverage based on estimated rodent territory size and movements. Analysis of trap data can also help to reduce incidental mortality to small birds and mammals by identifying incidental catch hotspots for deployment of more specific trap and bait combinations. Photo-database capabilities are used to store photographic records of rat station locations and document trap maintenance.

Temporal Effects at Multiple Scales: The Influence of Habitat Fragmentation on Nest Predation Risk for the Marbled Murrelet

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The marbled murrelet (Brachyramphus marmoratus) is a threatened seabird dependent on old-growth forests for nesting habitat. Forest fragmentation may cause murrelet population declines greater than those predicted from habitat loss alone. This can result from detrimental “edge effects”, when predation rates are higher at habitat edges relative to interiors. However, there is little consensus on the magnitude of edge effects on marbled murrelets, or how they might vary by edge-type. We compared the fates of experimental murrelet nests at paired edge and interior locations at 105 sites in four regions of southwestern British Columbia, Canada. Sites were choosing at “hard” edges (recent clearcuts), “soft” edges (regenerating forest), and natural edges (i.e. riparian areas). Nest cameras were used to distinguish disturbances caused by known predators of real nests. Disturbance patterns in the initial two regions suggest detrimental edge effects at hard edges, lower predation risk at soft edges, but no edge effects at natural edges. These results imply that detrimental edge effects adjacent to recent clearcuts may decline with time due to successional processes. Analyses of the combined dataset demonstrate that this pattern is consistent across all four regions, suggesting that management recommendations can be applied to murrelet habitat throughout southwestern British Columbia. Effects of the forest mosaic at the landscape-scale corroborate our results of temporal effects on nest disturbance risk at the patch level. Where corvids are important predators, we recommend that managers implement harvesting strategies that lessen the amount of hard edge at both patch and landscape scales.
Patterns of Vocal Activity at a Multispecies Petrel Colony: Predators, Competitors, and the Cost of Nocturnal Behavior

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Predators are thought to influence diel patterns of reproductive communication at many seabird colonies. Three lines of evidence are consistently cited to support this theory. First, many seabird species are nocturnally active at breeding colonies where they face a threat from diurnal predators. Second, in colonies where diurnal predators can hunt by moonlight, nocturnal seabirds often reduce courtship behavior when the moon is visible. Finally, typically nocturnal species have diurnal populations at some colony sites where daytime predation pressure is reduced or where individuals face a threat from a specialized nocturnal predator (e.g. Short-eared Owls, Asio flammeus). I recorded the vocal behavior of two nocturnal petrel species, the Juan Fernandez Petrel (Pterodroma externa) and Stejneger's Petrel (P. longirostris), breeding in a colony with a strictly diurnal predator (Red-backed Hawk, Buteo polyosoma exsul) to see if either species avoided moonlight in the absence of nocturnal predation. Counts of aerial vocalizations during the incubation and chick-rearing period (2004, 2005) show that Stejneger's Petrels and Juan Fernandez Petrels increase vocal activity when the moon is present ($F_{1,124} = 9.79$, $p<0.05$ and $F_{1,124} = 22.17$, $p<0.001$ respectively), and that Juan Fernandez Petrels increase vocal activity as the fraction of the moon illuminated increases ($F_{1,124} = 123.79$, $p<0.001$). These results support the idea that predator identity can affect reproductive behavior in seabirds and suggest a potential cost of nocturnal display behavior. Furthermore, differences in the potential costs of nocturnal behavior may account for the observed differences in the nightly pattern of communication for each species.

Population Genetic Structure in the Double-Crested Cormorant

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Management efforts for the Double-crested Cormorant (Phalacrocorax auritus) vary widely across North America and an understanding of population structure is necessary for delineating appropriate management units. Four subspecies of Double-crested Cormorants have been described: P. a. auritus breeds in the interior and northeast; P. a. cincinatus breeds in Alaska; P. a. albociliatus breeds along the Pacific coast; and P. a. floridanus is a resident in the southeast. We examined genetic structure of the species in North America to quantify variation within and among breeding areas and to test for presence of distinct populations. Sequences from the mitochondrial control region were analyzed for 192 individuals from 19 breeding sites. Variation was also examined at 9 microsatellite loci for 361 individuals from 19 breeding sites. The mtDNA and microsatellite data provided evidence that genetic variation is high across breeding areas and supported the presence of genetic structure. The distribution of genetic variation was consistent with current taxonomy in identifying birds from Alaska (where numbers are low and declining) as distinct and recognizing differentiation between the Pacific and the rest of North America. However, there was no support for differentiation between the southeast and the interior/northeast, while there was a difference between southern California and other sites. Further, there was greater genetic diversity and divergence within the Pacific region compared to the interior/eastern region, where cormorant population size is an order of magnitude greater. These results and analyses in progress will more definitively resolve taxonomic issues and provide guidance for conservation and management.
Movement Ecology of Gannets and Murres in the NW Atlantic

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Foraging seabirds exhibit both flexible and persistent behavioural tactics in response to the dynamics of prey availability. Here we overview studies of the movement ecology of the dominant plunge-diver (Northern Gannet) and the dominant pursuit-diver (Common Murre) that prey on capelin (the dominant forage fish) and large pelagic fish and squid in the NW Atlantic. We integrate studies of parental diets, at sea surveys of birds and prey and data-logger studies. We demonstrate flexible and persistent behavioural tactics in horizontal and vertical dimensions and examine how these change in the face of varying prey conditions. At larger ocean-basin scales, migratory movements of marine birds from and to the NW Atlantic are also presented. Implications of the year-round movement patterns of seabirds for population ecology are considered.

Seabirds Help Detect Arctic Ecosystem Change: A Canadian International Polar Year (IPY) Initiative

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The primary objective of our International Polar Year project (2006-2011) is to use seabirds to detect climate-induced biological changes in High and Low Arctic regions in eastern Canada. Research centers on key forage species (Arctic cod, capelin, Myctophids, crustaceans) and their seabird predators. In collaboration with Inuit researchers and Newfoundland fishers, we use seabirds to sample the marine environment over multiple spatial and temporal scales. Seabird diets, reproductive performance, foraging and migratory tactics are measured and evaluated as indicators of changes in food-web and ocean conditions (temperature, sea ice). Synoptic research in the High and Low Arctic is integrated through a ‘downstream’ (Labrador Current) link to evaluate influences of High Arctic climate on marine life in Low Arctic ecosystems. Seabird diets collected during 2007-08 extend existing time series data (1970s and 1980s) and assess changes in zooplankton and forage fish in relation to regional and holarctic physical oceanography. Miniature bird-borne data loggers are employed to track year-round foraging and migration behaviour and habitat use. Vessel surveys conducted around colonies provide information on oceanographic conditions and the distributions of birds, fish, crustaceans and marine mammals synoptic with collections of seabird diets at colonies and at sea. Integration of these data will assess the influence of changing ocean climate on predator - prey dynamics. We use interactive outreach projects to disseminate and gather information in local communities.
Survival and Recruitment of Tufted Puffins

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Tufted Puffins (Fratercula cirrhata) are a long-lived seabird exhibiting delayed maturity and high adult survival. Juvenile survival to recruitment age is likely to be important to population dynamics, although little is known about factors that affect juvenile survival in the Alcidae. The number of puffin fledglings produced and the date and mass at fledging varies considerably between years on Triangle Island, BC. In 1999 and 2000, 92 and 84 Tufted Puffin chicks were banded respectively. Forty-one of these were resighted at their natal colony 2002-2007. We used an information theoretic approach to evaluate the effects of year, fledging date, and fledging mass on the probability that individual chicks returned to the colony. The best-supported model explaining variation in probability of returning included fledging date and received nearly twice the support of the third best-supported model which included fledging mass. Banded puffins were resighted for the first time at 3-7 years of age. We used a similar information theoretic approach to assess whether fledging mass and fledging date affected age at first return. Unlike the probability of returning, fledging mass was more important than fledging date to age at first return. Tufted Puffin chicks that fledged at heavier masses returned to their natal colony at a younger age than lighter fledging chicks. This result is also important to puffin population dynamics, because we have found that age at first return is positively related to age at first potential breeding.

The Changing Population Status of Black-Legged Kittiwakes At Bluff, Alaska, a Multi-Colony Perspective

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Numbers, breeding chronology and breeding success of Black-legged Kittiwakes (Rissa tridactyla) at Bluff, a coastal colony in Norton Sound, Alaska, have been documented for the past 3 decades. Numbers of adults increased from the mid-1970's through early 1990's and then decreased. Breeding chronology and productivity varied markedly among years. Numbers of nests were highest, hatching was earliest, and productivity was highest in years when conditions in late spring were warmest. Although complete breeding failures occurred in several years, estimated productivity averaged 0.4 fledglings/nests overall (n= 29 years), higher than at any other colony in the Bering Sea where long-term data have been collected. Although annual variability in productivity at Bluff paralleled that at Cape Peirce, a much larger coastal colony to the south, productivity averaged significantly higher at Bluff. Numbers of adults at Cape Peirce have also declined since the early 1990's but at a higher rate. These results appear consistent with expectation that declines would be less at more productive colonies. Breeding chronology and productivity were positively but weakly correlated between Bluff and both Cape Thompson and Cape Lisburne, 2 large coastal colonies to the north in the Chukchi Sea and also St. George Island in the Pribilof Islands in the Southcentral Bering Sea. Surprisingly, breeding chronology and productivity were strongly positively correlated between Bluff and St. Paul Island in the Pribilof Island group, suggesting that adults breeding at these distant colonies in contrasting marine zones over-winter in similar or overlapping regions and enter pre-breeding in similar condition.
Nesting Habitat, Activity Patterns, and Distribution of Marbled Murrelets at Port Snettisham, Southeast Alaska

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We radio-marked 111 Marbled Murrelets (Brachyramphus marmoratus) at the mouth of Port Snettisham (PS), Southeast Alaska, and followed their movements and activity patterns during spring and summer 2005-2007 using data loggers and boat surveys in PS, and aerial surveys throughout the inner passages of Southeast Alaska and inland into Canada. We located 18 nests up to 52 km inland in PS and the Whiting River drainage of adjacent British Columbia (BC). Seven nests were suspected to be in trees, 8 on cliff ledges, and 3 in undetermined locations. PS served as an important foraging area for marked and unmarked murrelets and other seabird species. During incubation and chick-rearing, breeding birds foraged in close proximity to nests (0 = 20 km, excluding BC nests), while post-breeding and non-breeding birds were found as far as 200 km from PS. The number of radio-marked murrelets attending PS declined steadily throughout each season with most departing by late July. We documented daily movements of murrelets into PS in the early to mid morning hours (00:00-08:00 h) and out of PS during the night (20:00-02:00 h). In 2007, murrelet numbers in PS were related to tide stage and fish target counts. A variety of forage fish and plankton species were present in PS, with Capelin (Mallotus villosus) and juvenile salmonids being most abundant in our dip net and beach seine sampling, respectively. Our findings help to fill a major gap in knowledge of murrelet breeding biology in Alaska, where populations are experiencing large-scale declines.

Strait of Georgia – How Has it Changed?

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The Strait of Georgia ecosystem has changed dramatically over the past 100 years and is expected to change even more dramatically in the future. Large predatory fish including lingcod and a variety of rockfish species have been fished to very low abundances over the past century. Pacific cod and capelin have also virtually disappeared. Other species such as Pacific hake and Pacific herring have increased in numbers. Pacific hake is now the dominant fish species in the strait and herring recruitment was at record levels at the turn of this century. The increase in hake may be in part due to the reduction of the large predatory fish, however the increase in abundance has also provided an abundant food source for harbour seals which have dramatically increased in abundance since the 1970s. The dynamics of Pacific salmon have also changed in the strait. Historically the strait supported strong recreational and sport fisheries for coho and chinook salmon. The condition of these stocks is now considered critical, even though millions of juveniles are released from hatcheries each year. Pink and chum salmon, on the other hand, are doing exceptionally well in the Strait of Georgia and juveniles of these species are rearing for extended periods in the strait. These changes in biological dynamics have occurred hand in hand with changes in the physical properties of the strait. The Strait of Georgia is at least 1oC warmer than it was 100 years ago and this warming will continue. In addition, due to changes in Fraser River flow patterns and in the intensity of winds in the late winter, it appears that there may be a trend towards earlier primary production. This change appears to be benefiting species that utilize the strait earlier in the year, including pink and chum salmon and Pacific herring. Coho and chinook salmon which enter the strait later are not encountering the food resources they require or are finding increased competition. Understanding these changes is important for all researchers studying species that utilize the Strait of Georgia.
Predicting At-Sea Abundance and Mortality of Monterey Bay Seabirds

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Our understanding of seabird population dynamics and mortality is derived primarily from colony-based studies of fecundity and survival. Little is known about factors that regulate mortality at-sea during the non-breeding season and the effective evaluation of human impacts on seabirds requires a full understanding of fecundity and mortality during both the breeding and non-breeding seasons. We examined seabird mortality at-sea by combining two large, ten-year data sets from Monterey Bay, California: the Monterey Bay National Marine Sanctuary BeachCOMBERS beachcast animal surveys and the Center for Integrated Marine Technologies seabird survey program. A key to understanding the significance of beachcast animals is linking beachcast data with seabird offshore abundance data as well as biotic and abiotic oceanographic conditions. We examined the relationship between physical and biological oceanography, seabird abundance at-sea and seabird mortality patterns. Unfortunately, the ability to predict at-sea abundances from beachcast abundance data and vice versa in Monterey Bay is limited as significant relationships were not found between either the overall abundance data or functional groups of at-sea and beachcast assemblages. For all analyzed groups except Common Murres and Sooty Shearwaters, significant relationships do not exist between at-sea and beachcast abundances unless environmental habitat variables are included the models. We conclude that at-sea surveys alone are not good predictors of mortality, and that beachcast seabirds are poor indicators of at-sea abundance for most seabirds.

Do Rhinoceros Auklet Cerorhinca monocerata Chicks Compensate their Growth for Nutritional Stress?

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Temporal variation in meal size through local marine environmental changes affects chick growth of seabird. However, it is not clear how chicks received temporal food deficit derived from marine environmental changes could compensate their growth after provided food surplus. We examined whether Rhinoceros auklet chicks could compensate bad growth caused by a poor nutritional environment in early growth phase when the nutritional environment shifted to rich in the later phase. Chicks were provided a constant meal size (50 g) in control, provided a small meal size (30 g) in early phase and a large meal (70 g) in late phase, and provided a large meal size (70 g) in early phase and a small meal (30 g) in late phase. Chicks varied their body mass with their meal size. Fledglings (55 days of age) did not vary their body mass, wing length, head length, bill depth and tarsus length among experimental groups. Thus, chicks provided nutritional deficit in early or late phase could fledge without any appearance of nutritional stress. This ability of compensation growth could be favorable for survival of fledglings.
Significant Surf Scoter (*Melanitta perspicillata*) Use of the Salish Sea Region during Spring Migration and Molting in Late Summer, Documented through VHF and Satellite Telemetry

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Wintering populations of Surf Scoters (*Melanitta perspicillata*) from Puget Sound, the Strait of Georgia, San Francisco Bay, and Baja Mexico move to various key marine areas along the Pacific Flyway during both spring migration and the late summer molting period. Surf scoters from these four wintering populations were implanted and tracked 2004-06 with both satellite and VHF transmitters. During spring, Surf Scoters from all four wintering populations used the Puget Sound/Georgia Basin region in some fashion. This region was utilized as a spring marine staging area by nearly all surf scoters wintering in the Puget Sound, and was the only marine spring staging area used by 56% of these Surf Scoters. This region was also used during spring by 41% of PTT-transmitted Surf Scoters wintering in San Francisco Bay. Spring locations utilized by surf scoters outside of the herring spawn locations included Padilla Bay through Lummi Bay, Boundary Bay, Fraser River Delta, and the western Strait of Georgia and Howe Sound. Surf Scoters seemed to employ numerous feeding strategies during spring, with feeding on herring spawn being only one, as the majority of transmitted Surf Scoters utilizing the region during spring did not utilize herring spawn events. Certain key areas in the Salish Sea, such as Fraser River Delta and Padilla Bay, consistently attracted sizeable numbers of returning scoters in late summer, where these birds then experience wing molt. Adult female Surf Scoters were often the largest component of these molting groups.

Effects of Long Fasting on Growth and Body Temperature of Streaked Shearwater *Calonectris leucomelas* Chicks

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Extremely long foraging trips by shearwater parents result in serious fasting for their chicks. How this long fasting affects chick growth and body temperature is not fully understood. Chicks of streaked shearwater sometimes experience long fasting (≥ 3d). So we measured growth of the chicks (30 day age) of this species under three different feeding schedules during 55 days; (a) NORMAL (fed every day), (b) SHORT FASTING (fed every two days), (c) LONG FASTING (fed every six days). After the experiments, the chicks of all groups were not fed during three days with recording stomach temperature by using data-logger. All chicks were sacrificed to measure development of internal organ and nutritional state in the end. SHORT and LONG FASTING chicks decreased their body mass during fasting period. LONG FASTING chicks showed depression of wing growth as well between the 5 – 6th fasting days. However, total mass gain, wing growth, weight of internal organ and nutritional composition at the end of the experiment did not differ between groups. Body temperature of LONG FASTING chicks were maintained about 38 ºC but those of NORMAL and SHORT FASTING chicks were decreased to 26 - 28ºC during 23:00 – 6:00. Thus, long fasting gave short-term adverse effect on chick growth but did not affect overall chick growth if sufficient food was delivered after the fasting. Our results indicate that the chicks have a physiological ability for extremely long fasting so they may maintain their growth.
**Trends in Oil Spill Rates and Impacts on Marine Avifauna in the Canadian Salish Sea over the Last Decade**

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I will review spatial distributions and rates of oil spills based on 10 years (1997-2006) of National Aerial Surveillance Program (NASP) data. Hotspots will be identified and possible causes for these hotspots will be discussed. I will also show how these trends are reflected in Beached Bird Surveys conducted throughout the region and discuss why results from these surveys may or may not reflect oil spill rates nearby.

**Using Fatty Acids to Detect Sex Differences in Diet During the Pre-Laying Period in Three North Sea Seabird Species**

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Information about seabird diet is incomplete. This lack of information is particularly acute during the pre-laying period; a critical time in which the birds’ condition can influence both the success of a breeding attempt and future survival. Prior to laying, the sexes are subject to different physiological, behavioural and ecological constraints which could result in distinct foraging strategies of males and females. This question has received little attention and the few studies that have looked at pre-laying diet provide an incomplete picture due to the approaches used (lethal sampling with consequent small sample sizes, and opportunistic sampling during mass mortality events). Here we present recent data from a different approach using qualitative fatty acid analysis. Blood was collected from Northern fulmar (Fulmarus glacialis), black-legged kittiwake (Rissa tridactyla) and common guillemot (Uria aalge) to test for sex differences in fatty acid composition during the pre-laying and chick rearing periods. Two main conclusions arose. Firstly, marked sex differences in fatty acid composition exist during the pre-laying period in fulmars but not in kittiwakes or guillemots. Fulmars are generalist marine top predators with greater potential to exploit different prey species than guillemots and kittiwakes where both sexes may be restricted to particular prey. Secondly, this difference in fulmar diet is not present during chick rearing. We attribute this to higher energetic demands during chick rearing which limit birds to prey of high nutritional quality. Fatty acid signature analysis provides a non-destructive means of assessing variation in seabird diets across sexes and breeding phases.
Sex-Specific Differences in Diving Behaviour of Two Sympatric Alcini Species: Thick-Billed Murres and Razorbills

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Empirical evidence suggests sympatric seabird species partition the resources of their environment. Within species, the reasons behind sex differences in foraging behaviour remain unclear. We hypothesized sex differences in foraging behaviour of sympatric thick-billed murres (Uria lomvia) and razorbills (Alca torda) at Gannet Is. were driven by their parental roles. We expected females in both species to show similarities in their foraging behaviour because of their major involvement in chick provisioning. Murre females dived shallower and shorter than males, which appear to be due to the time of day they foraged. In razorbills, although there were no clear sex differences in the main dive parameters and foraging times, female razorbills tend to dive more often at twilight and to shallower depths (<10 m) than males. The tendency for shallow diving by females of both species may explain their shorter bouts despite the equal number of dives per bout and per day between sexes. We also found sex differences in dive profiles and prey in both species. Female dives were mostly shallower W-shaped dives, probably for capturing crustaceans at twilight. In contrast, males performed mostly deeper U-shaped dives for capturing mid-water species (e.g., capelin Mallotus villosus). Razorbill dives for capturing shallow schooling species (e.g., sand lance Ammodytes sp.) were V-shaped. Our results suggest a similar temporal segregation between the sexes in water depth, time of day, and prey during reproduction in both species. These differences were stronger in thick-billed murres than in razorbills, which probably reflect different selective pressures associated with their parental roles.

Prioritized Research Needs for Seabird and Waterbird Conservation in the Western Hemisphere

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Basic and applied research is essential to achieving conservation goals for aquatic bird populations. Due to the recent development of a number of avian and wildlife conservation planning tools, comprehensive information on identified research needs for waterbird and seabird conservation is newly available. However, this information is dispersed throughout national, regional and state bird conservation plans. The Technical Services Committee of the Waterbird Conservation Council undertook to bring these information needs to the attention of scientists throughout the western hemisphere. Our objective was to compile, synthesize and disseminate research needs information identified by conservation partners into a searchable catalog in order to facilitate adoption of critical research projects by ornithologists and conservation scientists. A total of 675 specific research needs were identified in 45 conservation plans developed by partners in thirty nations. The most commonly articulated research need was for habitat information especially as it pertains to protecting key sites. Contaminants studies were more often required at an ecosystem level than at an individual species level; however, some species groups, particularly loons, storm-petrels, ibises, and terns, were suggested more often than others as subjects for investigations. In Latin America, research needs were less specific, and often focused on acquiring baseline data on population size, distribution, life history, and habitat use. More in-depth projects, where proposed, often required this information as a starting point. Other patterns in research needs articulated in Americas bird conservation plans, and directions for catalog use are available at the Waterbird Conservation for the Americas website (www.waterbirdconservation.org).
North Pacific Research Board and National Science Foundation Partner in Comprehensive Study of Eastern Bering Sea Ecosystem

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The North Pacific Research Board (NPRB) and National Science Foundation (NSF) are partnering to study the eastern Bering Sea shelf ecosystem and how it may respond to climate change and loss of sea ice. It will include three field seasons in 2008-2010 and two years for analysis and reporting. It is based on the NSF 2005 Bering Ecosystem Study and NPRB Bering Sea Integrated Ecosystem Research Program. Nearly $50 million will support this program: $14 million from NPRB, $21 million from NSF, and the remainder in matching funds from NOAA, U.S. Fish and Wildlife Service, and U.S. Geological Survey. Over 70 federal, state, and university scientists will be involved, from Alaska, Washington, Oregon, and British Columbia. NSF will study atmosphere and ocean physics and lower trophic levels, including physical and biological sampling around sea ice and on the ocean floor, primary production near sea ice, nutrients and stratification, and energy transfer through zooplankton. NPRB will emphasize forage fish, commercial fish species such as pollock, Pacific cod, and arrowtooth flounder; northern fur seals, walrus and whales; and thick-billed murres and black-legged kittiwakes. Foraging patterns of marine mammals and seabirds will be studied within large prey aggregations near the Pribilof, Bogoslof, and St. Lawrence Islands. NPRB also will support local and traditional knowledge research. Federal matching funds from NOAA, USGS, and USFWS will support trawl surveys; seabird telemetry; and studies of fur seal pups and persistence of foraging hotspots. An innovative ecosystem modeling activity will tie the program components together.

Are Puget Sound Rhinoceros Auklets (Cerorhinca monocerata) Diet Limited?

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To assess whether or not Puget Sound rhinoceros auklets are diet limited, we compared reproductive success and chick diet of birds nesting on Protection Island in the eastern Strait of Juan de Fuca and on Tatoosh Island on Washington’s outer coast in 2006. In addition to examining a potential mechanism for seabird declines, this Sound-coast comparison helps us determine if events unique to the Sound are driving the declines. To measure reproductive success, we monitored burrows with infrared burrow probes and, to measure chick diet, we collected bill loads of fish from adults by mistnetting or spotlighting birds arriving at the colony. Preliminary results indicate that burrow occupancy was remarkably similar between islands (Protection = 80%, Tatoosh = 82%) and reproductive success was slightly lower on Protection (Protection = 75%, Tatoosh = 81%). Over 1000 fish samples (134 bill loads) were collected from auklets over 7 sampling trips. Protection Island birds carried more fish per bill load (Protection = 12.02 ± 1.09, Tatoosh = 6.07 ± 0.74) but carried smaller fish (Average wt.: Protection = 27.01 ± 1.90g, Tatoosh = 33.99 ± 2.63g). Energy content per bill load was higher on Tatoosh (Protection = 130.6 ± 10.3kj, Tatoosh = 184.4 ± 18.7kj). Protection birds may be working harder (more fish captures per trip) for a lower return to their chicks (lower bill load weight and energy content) than outer coast conspecifics, perhaps with a slight impact on fledging. These results should be interpreted with extreme caution, as interannual variation in colony reproductive rates and in chick diet can be large.
To Fly or Not to Fly: High Flight Costs in a Large Sea Duck Does Not Lead to an Expensive Lifestyle

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To determine whether flight has evolved mostly to facilitate access to food or as an anti-predator strategy is a perennial question in ornithology. However, flight is an expensive mode of locomotion and species using flight regularly are associated with an expensive life style. Using heart rate data loggers implanted in 13 female common eiders (Somateria mollissima), our objective was to test the hypothesis that a high level of flight activity increases their energy budget. We used the long-term recording (7 months) of heart rate (HR) as an index of energy expenditure and the heart rate flight signature to compile all flight events. Our results indicate that the eider is one of the thriftiest volant birds with only 10 minutes of flight time per day. Consequently, we were not able to detect any effect of flight activity on their energy budget despite very high flight costs (123 to 149 W), suggesting that flight was controlled by physiological constraints. However, the low flight activity of that species may also be related to their prey landscape requiring few or no large scale movements. Nevertheless, we suggest that the (fitness) benefits of keeping flight ability in this species surpass the costs by allowing a higher survival in relation to predation and environmental harshness.

Hawaiian Petrel (Pterodroma sandwichensis) on the Island of Lana‘i, Hawai‘i – A Previously Unknown Breeding Colony

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The endangered Hawaiian petrel (Pterodroma sandwichensis) was known to have a significant breeding colony only on the island of Maui, but was suspected to be present on the island of Lana‘i. Night-time surveys were initiated in March 2006 to determine the status of the petrel on Lana‘i in the forested watershed at the top of the island (elevation 1,030m). Listening surveys and observations using night vision equipment documented the presence of a substantial breeding colony. Surveys indicated predation by feral cats and barn owls and collisions with the watershed protection fence. Initial activities also included predator control and fence visibility enhancement. The Lana‘i colony differs from Maui in habitat characteristics and breeding chronology. Maui birds nest in rocky crevices with scant vegetation and begin breeding in early February, while the Lana‘i petrels breed in dense uluhe fern habitat (Dicranopteris linearis and Diplopterygium pinnatum) and start breeding in March. The newly discovered colony faces an additional threat with the anticipated construction of wind towers. Lana‘i is privately owned by Castle and Cooke (C&C), which has begun assessing the feasibility for commercial production of electricity using wind resources. State and federal agencies are working with C&C to address potential take of this endangered species. Minimization and mitigation practices are being evaluated. Habitat restoration focusing on removal of invasive strawberry guava (Psidium cattleianum) is one proposed strategy that would restore and enhance the Lana‘ihale watershed to the benefit of the Hawaiian petrel.

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Modeling Oiling Mortality Impacts on Common Murre (Uria aalge) in Central California

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A combination of mortality factors including chronic oiling, gill netting, and oceanographic variability are thought to be preventing population recovery of Common Murre (Uria aalge), which is 10% of historic estimates. We modeled the effects of oil spill-related mortality on the central California murre population growth rate using a stage-based, deterministic population matrix. We obtained parameters from published reports to obtain data including annual population size estimates, survivorship among age classes, number of chicks fledged, estimates of low levels of chronic oiling mortality, and mortality associated with large scale oil spills. We used this model to analyze population trajectories and predict impacts of low-level chronic oiling (1 to 15% per annum) and catastrophic oil spill mortality (>20% per annum, once every 20 years) on population growth rates. Results indicated that population growth is expected to be approximately 4% annually. The model predicted that chronic oiling rates greater than approximately 2.5% per annum have the potential to be detrimental to population growth. Additionally, the model indicates that periodic catastrophic oil spills, even in the absence of chronic oiling, will slow population growth rates to those similar to currently observed trends in central California. This preliminary project provides researchers with a framework to develop more comprehensive predictive models to understand the complexities of population recovery and how future oil spill mortality will impact the recovering Common Murre population in Central California.

The Extraordinary Ecology and Conservation of Brachyramphus Murrelets

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Brachyramphus murrelets, including marbled, Kittlitz’s and long-billed, are among the most fascinating and secretive of all seabirds. Most of what we know about the basic biology of these birds—such as where they nest, where or what they eat, and the size of breeding populations—has only been determined during the past few decades. We have been astounded to learn that marbled murrelets nest in the canopy of ancient temperate rainforests while Kittlitz’s nests on mountain peaks, usually in the vicinity of glacial ice fields. Nearly identical in body size and morphology, both species feed on similar prey and overlap considerably in foraging habitats—although basic ecological theory says they should not. Since Brachyramphus murrelets are among the few seabirds of the world with cryptic plumage, and it appears that many aspects of their biology and behavior have been shaped by the pressing need to avoid predation. Recent syntheses of available information suggest that populations of both marbled and Kittlitz’s are declining rapidly throughout their ranges, and that declines may be linked to climate- and human-induced changes in habitat quality, predator abundance and prey availability. Whenever we try to characterize the extraordinary ecology of murrelets in order to protect them, however, we find exceptions among individuals and regions; hence, developing a conservation strategy is anything but straightforward. Rising rapidly from their scientific and public obscurity, Brachyramphus murrelets have become iconic symbols of old-growth and glacial ecosystems in the U.S. and Canada, as well as “poster-children” for impacts of logging of old-growth forests and global climate change. Indeed, few seabirds have generated more controversy, elicited more lawsuits, had more economic impact or inspired more extreme environmental activism than these murrelets. With murrelet populations declining and human impacts increasing, murrelets will likely command our attention in the North Pacific for decades to come.
A Wing and a Prayer: Masked Boobies Feed Wing-Deformed Chicks into Adulthood at Clipperton Island

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During a March 2005 visit to Clipperton Island (10° 18’ N, 109° 13’W) in the eastern tropical Pacific, we observed a large number of Masked Booby (Sula dactylatra) chicks with deformed wings (usually one, but occasionally both) - a condition that was going to prevent them from ever leaving the island. We conducted a line transect survey around the island and estimated that 460 chicks were afflicted (4.4%, n = 10,375). In addition, a minimum of seven of these birds were in adult plumage (i.e., minimum 2-3 yrs old) and still being fed by their parents. This is, to our knowledge, the longest period of time that an adult bird of any species has been recorded feeding young at the nest. Furthermore, these observations indicate that the time and age at which Masked Boobies fledge is, at least in some cases, determined by the chick and not by the adult. The wing deformity was superficially similar to a condition in waterfowl known as “angel wing” - a developmental aberration usually attributed to excess protein in the diet (not likely in a solid). Although the cause of the deformity could not be determined, because it was accompanied by a recent chick die-off, we suspect that it may have been related to nutritional stress.

Raccoon and River Otter Predation on a Large Leach’s Storm-Petrel Colony

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Leach’s Storm-Petrels (Oceanodroma leucorhoa) are burrow-nesting seabirds that breed on islands in the northern Pacific and Atlantic. There are 6 significant colonies of Leach’s Storm-Petrels in Oregon. The 3rd largest in the most recent colony survey (1989) was located on Saddle Rock (N 42.250 W -124.414) with an estimated 87,500 birds nesting. This site is vulnerable to terrestrial predation due to its contiguity with the mainland at low tide. In recent years, an increase in visitation of raccoons and river otters to Saddle Rock has resulted in increased bird mortality. In summer 2007 I monitored nesting density and burrow occupancy rates on Saddle Rock to assess predation pressure. I compared these data with those from the nearby, mammalian predator-free Hunters Island (N 42.324 W -124.425). Saddle Rock now hosts significantly lower densities than Hunters Island, when historically, Saddle Rock had the higher density. Comparisons of Saddle Rock nesting density and burrow occupancy with data from 1979-1995 show a steep population decline. I collected storm-petrel carcasses and mammalian scat bi-weekly from February 2007 through October 2007. Carcass collection conservatively estimates predation rates ranging from 0 to 59 birds per night, with predation occurring on 7 of 11 nights checked. Predator scat analyses indicate that the local raccoons rely more heavily on storm-petrels than the river otters. 48% of marked burrows were preyed upon throughout the season. My data suggest that the Saddle Rock Colony, once thought to be one of the largest in Oregon, is now in danger of extirpation.
Abundance and Productivity of the Marbled Murrelet in the San Juan Archipelago, Washington, USA

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We conducted annual variable-distance transect surveys of Marbled Murrelets (Brachyramphus marmoratus) in nearshore waters around the San Juan Islands, Washington, from 1995 to 2007. Mean density, weighted by the inverse of SE of density, was 5.45 murrelets per km². Annual variation was large; mean density varied from 2.25 to 14.01 murrelets per km². We found no evidence of an increasing or decreasing trend over the years of our study, but annual estimates increased with increasing values of an index of sea surface temperature (R² = 0.34). Productivity, as estimated by the ratio of HY to AHY birds, was also highly variable, averaging 0.098 and ranging from 0.030 to 0.135. Productivity, like density, had no significant linear trend over the years of our study but did show a positive and significant correlation with the sea surface temperature index. We speculate that numbers and productivity of murrelets increased in years with warmer sea conditions in response to greater availability of prey in the San Juans, an ecosystem driven more by local tidal influence than offshore upwelling. In years when nutrients are more limiting in the outer coast, murrelets may move to the more nutrient-rich waters of the San Juans.

Natural Resource Assessment of Wake Island after Feral Cat Eradication and Super Typhoon Loke

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In 2005, we concluded our feral cat (Felis catus) eradication efforts knowing a few remained. One year later, Wake Island Air Field was struck by Super Typhoon loke on Aug. 31, 2006. Winds over 130 mph knots damaged many structures and broke many trees. Initial fears that a 50-foot storm surge from the typhoon would submerge the entire island did not materialize and the island was soon functioning again. In June 2007, we surveyed the island and found two feral cats are known to remain but may be the same sex. No cat reproduction has been detected. Bird populations were near previous levels; birds likely dispersed away from the typhoon. In spite of all the ironwood trees losing their needles, White Terns (Gygis alba) and Black Noddies (Anous minutus) were benefiting from the damage. White Terns used broken snags to nest on and needle regrowth better supported noddie nests. Brown Noddies have started to nest on the ground in the newly recolonized main Gray-backed Tern (Onychoprion lunata) colony; but a smaller colony was lost to loke. Water damaged two new Wedge-tailed Shearwater (Puffinus pacificus) colonies that had developed since cats were removed but the main colony continues to grow. Polynesian rats (Rattus exulans) have increased in the absence of cat predation. Rat control is problematic due to hermit crab competition for bait. We developed a novel bait station that excludes hermit crabs. In October, 2007, a rodent assessment team found another species of rat, Asian ship rat (R. tanizumi), and laid the groundwork for a rodent eradication program.
Murres, Capelin and Ocean Climate: Inter-annual Associations across a Decadal Shift

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To help ensure that the energy demands for reproduction are met, it is essential that marine birds time breeding to coincide with peak food availability. We examined associations of the breeding chronology of common murres (Uria aalge) with the timing of the inshore arrival of capelin (Mallotus villosus; primary prey of murres and other large vertebrates in the Northwest Atlantic) at Cape St. Mary’s, Newfoundland over a 27-year period from 1980-2006. We also assessed the influence of ocean temperature, and the North Atlantic Oscillation (NAO) on these interactions. We found a lagged linear relationship between variations in murre breeding chronology and the timing of capelin arrival in the previous year. On a decadal level, we found a non-linear relationship between ocean temperature and the timing of murre breeding and capelin arrival. A centennially anomalous cold water event in 1991 generated a pervasive shift in the timing of capelin spawning inshore and murre breeding, delaying both by more than 2 weeks. By the mid-1990s, ocean temperatures returned to pre-perturbation levels, however the temporal breeding responses of murres and capelin were lagged, remaining delayed for about a decade or longer. Owing to the complex nature of biophysical interactions at different scales, oceanographic conditions (temperature, NAO) were found to be potentially less reliable predictors of the timing of the inshore arrival of capelin compared to capelin timing in the previous year. Our results suggest that knowledge of the timing of capelin availability in the previous year serves as a robust cue for murres, allowing them to maximize the temporal overlap between breeding and peak capelin availability.

Evaluating the Power of Surface Attendance Counts to Detect Long-Term Trends in Numbers of Crevice-Nesting Auklets

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Population monitoring of crevice-nesting auklets is problematic because nesting occurs underground and attendance on the surface is highly variable. The most common monitoring methods are replicated counts of birds attending the surface on index plots, but statistical power to detect of these counts has not previously been evaluated, and overall sampling design has rarely been addressed. Models for surface attendance of least and crested auklets were developed and used in power analyses based on an 11-year data set from an Aleutian Island colony. We developed a hierarchical stochastic model for each Crested and Least auklets incorporating two ‘layers’: a logistic regression model predicting the probability of observing a non-zero count and a Poisson regression model for predicting the non-zero count observed. Both the logistic and Poisson regressions incorporated mixed effects to account for the major sources of random variation. The models were used in a simulation study to compare the power of different daily summary statistics, different seasonal sampling designs, and different monitoring durations to detect underlying trends. Trends, matching three levels of IUCN threats criteria, were simulated. We provided a framework for managers to make decisions about the value of surface counts relative to the amount of available effort. Attainable power is lower than for cliff-nesting species, but given >10 years surface counts can provide monitoring data at least sufficient to detect large declines. Some of the within-season variability can be removed through thoughtful protocol design. Additionally, selecting the best summary statistic can improve power by up to 10%.
The Effect of Changes in Fishing Regulations on the Distribution of Northern Fulmar (Fulmarus glacialis) in the Bering Sea

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In many parts of their range, Northern Fulmars depend heavily on offal from fisheries. The species has also shown to be sensitive to climate change. The Bering Sea underwent a regime shift in 1977, close in timing to a major change in fishing regulations with the proclamation of the Exclusive Economic Zone (1983). To isolate the effect of fishing practices, we compare the patchiness of the fulmar distribution at sea before and after enactment of the act. We find that fulmars are more evenly distributed in the 1980s-2000s than in the 1970s. This suggests that fulmar distribution was substantially influenced by fisheries and has returned to a more natural lifestyle.

A Post-Breeding Season Transect through the Beaufort, Chukchi and Bering Seas in the Lowest Ice Year on Record

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Arctic sea-ice retreated farther during the summer of 2007 than previously recorded. This loss of sea-ice was particularly pronounced in the East Siberian Sea and the northern Chukchi Sea. During September-October 2007, we surveyed seabirds on a transect from Cambridge Bay, NU, to Dutch Harbor, AK, on-board the CCGS Sir Wilfrid Laurier. We characterize seabird biomass density and species composition transiting from the Beaufort to the Chukchi and Bering Seas. Bird densities were low throughout the western Canadian Arctic and Beaufort Sea, Glaucous Gull being the dominant species. Once in the Chukchi Sea north of Point Barrow, seabird densities increased dramatically. Most common species in the northern Chukchi Sea were Black-legged Kittiwake and Ross’ Gulls. In the southern Chukchi and northern Bering Sea, Northern Fulmar, Short-tailed Shearwater, Black-legged Kittiwake and Least Auklets were the main species. Rare species encountered included Mottled Petrel (late record, 2 in SE Bering Sea), Dovekie (10 in Chukchi Sea) and Kittlitz’s Murrelet (66 at Barrow). Noteworthy was the absence of bowhead whales and walrus in the Chukchi Sea.
**Vertical Maneuvers during Submerged Swimming of Cormorants**

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Cormorants rely on submerged swimming for active search and pursuit of prey (fish). During straight, horizontal swimming cormorants use feet-propulsion while the wings are folded next to the body. Previous studies suggested that cormorants use their tail as a control surface to pitch (nose-up/nose-down moments) the body. Such a pitch-control mechanism would depend on the bird maintaining a high swimming speed throughout the maneuver. We studied the maneuvering performance and the control mechanism for performing large changes in attitude (pitch) while swimming in a 1m deep pool. Great cormorants (Phalacrocorax carbo sinensis) were trained to swim in an underwater obstacle course with increasing levels of difficulty. The course forced the birds to make a bell-curve shaped maneuver involving three consecutive changes in attitude. On average the birds (n=8) reduced their swimming speed by only 20% during the tightest negotiable maneuvers. At the center of this extreme maneuver the birds were able to turn in an average turn radius of 40% of their body length (~32 cm). In doing so they rotated their body at an average speed of 270°/s (SD= ± 51.6) and achieved a centrifugal acceleration in the order of 7.4 ± 1.6 m/s² or 0.76 times gravity (g). However, peak accelerations reached 1.5 ± 0.35 g and peak turn rate reached 460 ± 96.7 °/s. In the maneuvers the birds used their tail but also the neck to rotate the body and timed their paddling strokes to propel the body in the right direction through the obstacle course.

**Effects of Body Size on the Carrying Capacity of Habitat for Sea Ducks**

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Estimates of predator habitat requirements often invoked allometry between predator body mass and either habitat area or prey biomass. Allometry predicts that a given habitat area, or a given prey biomass, supports fewer numbers of larger animals. However, these relationships have not considered how foraging costs vary among locomotor modes, or how intake rates vary with accessibility and handling times of different-sized prey. Such aspects may alter threshold prey densities needed for energy balance, which determine the fraction of available prey. We compared the foraging profitability of larger White-winged Scoters (Melanitta fusca, 950–1800 g) and smaller Lesser Scaup (Aythya affinis, 450–1090 g) by combining data on metabolic costs of diving with intake rates of a common bivalve prey (Macoma balthica) of differing size, energy content, and burial depth. For scaup foraging on prey <12 mm long, all clams buried >6 cm in the sediment were unprofitable. However, the profitability threshold for clams buried <5 cm deep decreased from 740 to 160/m² for clams with an energy content of 50 to 200 J/clam, respectively. For the larger scoters eating larger prey (>18 mm), foraging was profitable on clams buried >6 cm deep at much lower prey densities (175/m²). Increasing energy content from 380 to 850 J/clam decreased this threshold to 70/m². If scoters swam by wings in addition to feet, threshold densities were 36–45% lower. Thus, unless niche partitioning among species and varying locomotor modes within species are considered, using allometry to predict predator carrying capacity from either area or prey biomass could yield erroneous estimates.
Birds of a Feather: International Teamwork Advancing Seabird Conservation on the High Seas

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In recent years, concerns about seabird bycatch in large-scale international fisheries have prompted several regional fisheries management organizations (RFMOs) to take action to assess and mitigate the impacts of fisheries on seabird populations. While progress-to-date among RFMOs varies widely, there is at least one thing in common among all of them – a willingness by the international community and interested nations to work together to minimize seabird bycatch by seeking rigorous impact assessments and the application of best practice mitigation measures. Input from mitigation gear technologists and scientists, working cooperatively with fishermen, has provided valuable scientific information to feed into the process of developing effective mitigation solutions that will reduce bycatch in fisheries. Working closely together, individual nations, such as the United States, as well as those organized by their membership in the Agreement on the Conservation of Albatrosses and Petrels, and well-respected international conservation organizations, such as BirdLife International, translate this information into expert advice and recommendations to RFMOs for use in addressing seabird bycatch. RFMOs currently addressing seabird bycatch include: CCAMLR, ICCAT, IATTC, WCPFC, and IOTC.\textsuperscript{1} While CCAMLR has achieved unprecedented success in reducing seabird bycatch, in the next few years, the other RFMOs will be faced with serious challenges to do the same. This poster provides snapshots of the progress-to-date on addressing seabird bycatch in each of these RFMOs and provides outlooks for the future in terms of likely outcomes and impacts to the most vulnerable seabird populations in the world.

\textsuperscript{1} Commission for the Conservation of Antarctic Marine Living Resources, the International Convention on the Conservation of Atlantic Tunas, the Inter-American Tropical Tuna Commission, the Western and Central Pacific Fisheries Commission, and the Indian Ocean Tuna Commission.

Top Predator Foraging Distributions around a Marine Reserve Recently Modified under California’s Marine Life Protection Act

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The Vandenberg State Marine Reserve was established in 1994 as a ‘no-take’ reserve, protecting resources consumed by both humans and top marine predators. In 2005, we concluded a six-year study of top predator foraging distributions within and adjacent to the reserve. Our results suggested the reserve was likely too small and inadequately placed to protect important prey populations. The reserve area was enlarged approximately tenfold under California’s Marine Life Protection Act, with new boundaries taking effect September 21, 2007. This provided the opportunity to amend our protocols and begin a new Before-After-Control-Impact (BACI) monitoring program. Our previous protocol used a paired design, monitoring stations within and adjacent to the reserve, with replicates on the windward and leeward sides of a coastal promontory. The modified protocol monitors stations within, adjacent (<1 km), and distant (>5 km) to reserve boundaries, with replicates in the north and south ends of the study area. Additionally, all stations have increased observation areas and are now leeward of coastal promontories, where fish and invertebrate recruitment is enhanced. Our ‘before’ observations were conducted from May through August, 2007. We monitored the foraging distributions of four seabirds (Brandt’s and Pelagic Cormorants, Pacific Loons, and Western Grebes) and three marine mammals (California sea otters, harbor seals and California sea lions). Seabirds and sea otters showed very similar distributions, while sea lions and harbor seals were most distinct. With the modified reserve now established, we will test its efficacy by monitoring station-specific changes in top predator abundance through time.
Managing Caspian Terns and Double-crested Cormorants to Enhance Recovery of Threatened Salmonids from the Columbia River Basin

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East Sand Island at the mouth of the Columbia River supports the largest breeding colonies of Caspian Terns (Hydroprogne caspia) and Double-crested Cormorants (Phalacrocorax auritus) in the world; neither of these colonies of native piscivorous waterbirds existed 25 years ago. Twelve of 20 Evolutionarily Significant Units of anadromous salmonids from the Columbia Basin are threatened/ endangered under the Endangered Species Act, due primarily to over-harvest, degraded habitat, hydropower dams, and hatcheries. Nevertheless, fisheries managers view avian predation as an impediment to restoring threatened salmonids because losses of juvenile salmonids to avian predators in the estuary are about 15 million/year, representing ca. 12% of all out-migrating salmonids that survive to the ocean. Management of avian predation, especially in the estuary, remains a component of the action agencies’ mitigation for the impact on listed salmonids of the federal dams. The federal agencies have recently initiated implementation of a controversial management plan for the Caspian Tern colony on East Sand Island, which seeks to create a total of 7 acres of tern nesting habitat at 3 sites in interior Oregon and 3 sites in San Francisco Bay, followed by a reduction in tern nesting habitat on East Sand Island to reduce the colony size by half. Attention is now shifting to the cormorant colony and its impact on smolt survival in the estuary, which now exceeds that of Caspian Terns. Studies are planned to assess the impact of cormorant predation on salmonid recovery and the feasibility of managing the size of the cormorant colony.

Association of Marbled Murrelets with Foraging Gray Whales on the Southwest Coast of Vancouver Island, British Columbia

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Marine birds and mammals are known to associate in many ways. For many, foraging in association with other species can be an important strategy that facilitates locating or capturing prey. Grey Whales (Eschrichtius robustus) forage on benthic invertebrates by scooping up bottom sediments. In this study, associations of Marbled Murrelets (Brachyramphus marmoratus) with foraging grey whales were assessed along a 105 km transect on the west coast of Vancouver Island, British Columbia in June 2005. Spatial association was analyzed at two scales; across the extent of the transect, and within a 50 m radius of surfacing whales. Results indicate that, at both spatial scales, murrelets were more closely associated with whales than would be expected by chance. Murrelets were observed feeding in direct association with foraging whales, and qualitative observations from plankton tows indicated that zooplankton were in much higher abundance near surfacing whales. More research is needed to elucidate this relationship. Identifying facilitative relationships among marine organisms will be important for understanding food web structure and adaptability to environmental change.
Aspects of the Breeding Biology of the Antarctic Tern *Sterna vittata* Gmelin, 1789 at Punta Crepin-King George Island (South Shetlands Islands)

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The Antarctic tern, (*Sterna vittata*), inhabits the subantarctic and maritime West Antarctic regions and breeds in coastal areas.

We describe habitat and nest site characteristics of Antarctic Tern breeding at Punta Crepin, Admiralty Bay. Information was obtained during the 2005-2006 breeding season. We recorded a total of 16 nests with eggs and/or chicks in a total area of 3 Ha, in a strip of 30m from seacoast to inland.

The breeding colony was in ice-free area on rocky and fine earthy substratum consisted of a scrape. Nests were located on open ground void of vegetation. Most nests had a rim made up from small stones. Most nests had a rim made up from small stones. Mean maximum and minimum diameters of nests were 17.96 ± 2.80 and 13.29 ± 2.34 cm. (n = 12), respectively. Number of eggs per nest was 1.6 ± 0.52. Antarctic Tern nested at low density (the densest area: 0.002 nests /m²). The minimum distance between nests was 7 m and the maximum was 380 m.

Mean dimensions calculated from 17 eggs were 4.53 ± 0.13 and 3.43 ± 0.20 cm. Mean volume for all eggs was 25.58 ± 3.27 cc. Not all one-egg clutches could be correctly classified as completed. Hence, the average clutch size was 1.55 eggs for all nests found (n = 11).

We found fewer nests than early one reported (56 nest in 1980/81 breeding season) in the same area. We recommend to assess the impacts of the nearby Antarctic Base and its activities on the Antarctic Tern colony and skuas which nests in the same zone.

Conservation Planning for Protection Island and San Juan Islands National Wildlife Refuges: Strategies for Seabird Management

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About 75% of Puget Sound’s breeding seabird population nests on the 84 islands, rocks, and reefs that comprise the Protection Island and San Juan Islands National Wildlife Refuges. Protection Island supports one of the world’s largest colonies of Rhinoceros Auklet (*Cerorhinca monocerata*) and a small remnant Puget Sound population of breeding Tufted Puffin (*Fratercula cirrhata*). Other breeding species include Pelagic Cormorant (*Phalacrocorax pelagicus*), Double-crested Cormorant (*Phalacrocorax auritus*), Pigeon Guillemot (*Cepphus columba*), Glaucous-winged Gull (*Larus glaucescens*) and Black Oystercatcher (*Haematopus bachmani*). Since the 1980’s, there have been marked declines in some of Puget Sound’s marine bird populations. Rhinoceros Auklets breeding on Protection Island are estimated to have declined by 30% during this same time period. Although the downward population trend is probably being influenced by widespread environmental factors, protecting their colonies remains critical to these species. The U. S. Fish and Wildlife Service is developing a Comprehensive Conservation Plan that will serve as a future management guideline for these critical seabird breeding islands. Preliminary strategies include exploring partnerships to create marine buffers around islands, maintaining existing public closures, determining optimal habitat attributes and implementing appropriate restoration techniques, controlling invasive and non-native species, removing marine debris and contaminated materials (e.g. creosote logs), and conducting research and monitoring activities necessary to support adaptive management decisions.
Interannual Spatial Variability of Krill Influences Seabird Foraging Behavior Near Elephant Island, Antarctica

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We investigated the influence of krill patchiness on seabird foraging behavior to understand how inter-annual variation in krill distribution influences patch dynamics between krill and seabirds. At sea surveys were conducted near Elephant Island for three years (2004-2006) during the Antarctic Marine Living Resources (AMLR) program. Standardized strip-transect surveys were used to map seabirds, and a combination of acoustic and net surveys was used to map krill. We measured patch size of krill and seabirds to ask whether if patch dynamics of krill influence where seabirds choose to forage. We found that the spatial association of krill and predators was influenced by the size and arrangement of krill patches. Consequently, we found opposing behavioral responses by Cape Petrels (Daption capense) and Chinstrap Penguins (Pygoscelis antarctica) to krill patches. Cape Petrels were spatially associated with krill when krill patches were clumped, whereas penguins preferred regions where krill patches were arranged in a more uniform fashion. Interestingly, we found that the relationship between abundance and patchiness of krill and krill predators was negative, indicating that when krill is less abundant, patches are more likely to be found in fewer areas. This study provided important insight on interannual patch dynamics of krill and krill predators at local scales. Such information could be used to interpret and predict potential interactions between seabirds and krill fisheries operating near Elephant Island.

†That Fish is so Last Year! Temporal Variation in Common Murre (Uria aalge) Chick Diets

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Understanding the foraging decisions seabirds face is crucial to an examination of the role seabirds play in marine environments. Diet is a function of the selection of prey items available, ocean conditions, and potentially social information and individual knowledge. During the breeding season, adults are further constrained by the need to choose food wisely for chicks as well as for themselves. Are changes in these constraining factors mirrored by changes in seabird chick diet? We use data collected on fish returned to chicks by adult Common Murres (Uria aalge) on Tatoosh Island, Washington, USA over a decade (1996-2007) to examine how diet changes over different time scales. For each year, between 700 and 2000 visual samples were collected from two subcolonies nesting on opposite sides of the island, including identification to lowest possible taxon, and fish length. Separate allometric and calorimetric analyses allowed for translation into energy density. Chick diet was comprised of 31 identifiable taxa. Pacific Herring (Clupea harengus pallasii) and Surf Smelt (Hypomesus pretiosus pretiosus) consistently dominated the diet, but the percent contribution of each varied interannually. The contribution of Pacific Sand Lance (Ammodytes hexapterus) and Eulachon (Thaleichthys pacificus) has decreased in recent years, while the contribution of Northern Anchovy (Engraulis mordax mordax) has increased. Diet diversity has also increased in the last three years.

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The Canadian Marbled Murrelet Recovery Team and colleagues have developed a robust radar monitoring plan to detect population trends and their causes for British Columbia, Canada. The Recovery Team has divided coastal British Columbia into six Conservation Regions. The design requires 3-4 early morning monitoring bouts at each of 10-15 long-term radar observation locations in each Conservation Region on a bi-annual basis to detect a decline of <1% per year over 10-12 years. The project has now completed three years of sampling and we will focus on the newest results from 2007. These new data, combined with the results of previous radar monitoring projects will help to develop a more comprehensive estimate of the Canadian Marbled Murrelet population and represent the makings of a powerful dataset to evaluate the population trends and their causes.

The Status of Breeding Seabirds on Eritrean Red Sea Islands

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There are very large numbers of seabirds and shorebirds in the Eritrean Red Sea. Here we assess the current status of species breeding on Eritrean islands. Breeding pairs and nest counts were determined by counting the number of occupied nests along the colonies of each species. During 2005-2007, three hundred twenty islands were surveyed, of which two hundred five harboured breeding species. In addition to confirmed records for 23 species of seabirds and shorebirds, the Socotra Cormorant, (Phalacrocorax nigrogularis), is suspected of breeding. If so, it would be the first record for the Red Sea. Confirmed breeding populations include Crab Plover, (Dromas ardeola), with more than 8,000 breeding pairs. The largest colony was recorded on Delgus (Assab bay), which hosts 1600 nests. Also observed breeding in high densities (5,900 pairs on 49 islands) was the White-eyed Gull, (Larus leucophthalmus), near threatened species endemic to the Red Sea and Gulf of Aden. More abundant was the Lesser-crested Tern (Sterna bengalensis), of which 60,000 pairs were recorded on 32 islands. Other abundant species included the Osprey, (Pandion haliaetus), breeding adults of which were recorded on 137 islands. The entire Eritrean islands may support up to 350,000 breeding seabirds in summer. The large numbers of islands, which are almost uninhabited, free of potential predators, and which provide suitable breeding habitats with sufficient food supplies, support very large numbers of breeding seabirds on the Eritrean islands. Local and foreign sea cucumber fishermen are currently the main threat to breeding populations.
†Incubation Shift Length and Egg Neglect in the Ancient Murrelet

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We investigated factors influencing variation in incubation shift length and nest attendance patterns of Ancient Murrelet (Synthliboramphus antiquus), a nocturnal, burrow-nesting seabird that lays two-egg clutch, at Reef Island in Haida Gwaii, British Columbia. Nest attendance and egg neglect were checked daily using knock-down tags and temperature probes to monitor 72 nest boxes. We also compared the mass of the birds for which incubation shift was experimentally extended with those ending normal incubation shifts. Ancient Murrelet pairs that successfully completed incubation had a mean incubation period of 33.6 ± 1.2 d (mean±SD). For 637 incubation shifts of 33 successful pairs, the mean shift length was (incubation prior to 15 days) was 1.66 ± 0.53 (mean ± SD) days. We compared mean shift length of incubators between pair members and these values are significantly correlated (n=39). This suggests that incubation shift length is determined, at least in part, by the behaviour of the mate. Successful incubation shifts (range 12 – 27, n=33). The mass of birds for which incubation shifts were artificially extended was lighter than those ending normal incubation shifts (p <0.05, n = 6, 85 respectively). Thirteen successful pairs temporarily neglected their eggs (range 1 – 3 d, once: 5 (38%), twice: 7 (54 %), three times: 1 (8 %). Our results showed that egg neglect was most frequent in the first half of incubation period, and rare in the second half of the incubation period when the investment of the parents has increased.

Assessing Models for Nest Site Selection by Marbled Murrelets in British Columbia Based on Ground Habitat Plots

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From 1998-2002, Simon Fraser University researchers obtained a relatively large, random sample of Marbled Murrelet (Brachyramphus marmoratus) nest sites through radio telemetry. Existing algorithms for habitat selection in this species are based on variables derived from Geographic Information System (GIS), Airphoto Interpretation and Low-level Aerial Surveys. Habitat suitability models currently used in British Columbia to rate forest habitat quality for Marbled Murrelets and prioritize reserve selection are based on these standardized, cost-effective methods. Habitat plots collected on the ground provide perhaps the most accurate indication of habitat available to nesting Marbled Murrelets at the patch scale. Our habitat selection models are the first for this species to use ground habitat plots and a sample of confirmed nests. Results are similar in some respects to previous findings using occupied detections. Density of trees with potential nesting platforms and trunk diameter (dbh) of canopy trees are strong indicators of nesting habitat, while landscape effects such as aspect and elevation may vary between our two study regions. We further investigate the specific relationship between certain ground variables and probability of nesting. Finally, we assess the ability of existing remote methods-based algorithms to predict important ground variables from our models.
Pelagic Behavior of Magellanic Penguins during Winter Migration

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Magellanic penguin (Spheniscus magellanicus) adult survival is generally high, and adult mortality is thought to be mainly from starvation during the winter, when the birds swim hundreds or thousands of kilometers from their breeding colonies. Magellanic penguins face a range of marine threats common to many highly mobile marine animals: petroleum pollution, by-catch in fishing gear, predation, and decrease in prey abundance due to increasing fisheries competition and climate change. A better understanding of their pelagic behavioral ecology is critical to successfully predict how birds will respond to environmental variation and anthropogenic modification of the marine environment. Satellite telemeters (platform terminal transmitters, PTTs) can reveal the locations of instrumented penguins at sea, but power constraints limit the amount of information than can be transmitted. Our satellite telemetry data on penguin movements during migration includes only their locations at various times, without any direct observations of behavior. To understand the ecological context of penguin pelagic behavior, we first must assign behaviors to this location data. This assignment is based on the distinction between two major types of behaviors used by penguins swimming and feeding in the ocean: transit and foraging. We hypothesize that we can characterize these behaviors from satellite telemetry locations, based on movement parameters related to velocity and turning angle. We have analyzed the degree to which sea-surface temperature and chlorophyll a concentration (proxies for ecological context) correlate with the inferred behaviors, and estimated parameters for the switching rates between behaviors as a function of these environmental variables.

Waiting for Murres to Reap the Benefits from a 1-Day Habitat Restoration Project (or How I Found Job Fulfillment in 6 Hours)

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As seabirds tend to be long-lived species, biologists who study them often come to understand that results, insights, and conservation pertaining to them are realized over the long term. It seems to be a rare occurrence when such events happen rapidly. This poster illustrates and describes an unusual event in which six hours’ worth of work for three people resulted in enhancing nesting habitat for several thousand common murres (Uria aalge). Barwell Island, which lay in the trajectory of the Exxon Valdez oil spill, is currently used by nesting murres as well as several hundred black-legged kittiwakes and glaucous-winged gulls; tufted puffin nesting was also suspected based on the presence of burrows with large entrances. During World War II the island was a small military outpost. As a “Formerly Used Defense” site, we partnered with the Army Corps of Engineers to investigate a reported “death trap” for murres. We remedied the situation that had trapped birds and intend to monitor the situation to ensure its continued success. While this particular circumstance is uncommon, its story is a vehicle for us to provide further outreach for seabird conservation regionally and beyond.
Unintended Consequences: Investigator Effects on Juan Fernández Petrel Chicks during a Provisioning Study

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The Juan Fernández Islands, Chile, have two endemic Pterodroma petrels, both listed as vulnerable by the IUCN. The ecology of these species is poorly studied and only one, the Juan Fernández petrel (Pterodroma externa), occurs in large numbers (1 million pairs). In 2001, a long-term research plot was established to describe the breeding biology of both petrels. The provisioning strategy of breeding Juan Fernández petrels was studied at the same colony from 2004-2005. In this paper, we investigated whether the methods used for the provisioning study (‘study’; frequent handling of chicks and data loggers on adults) affected petrel chick growth when compared to long-term monitoring methods (‘control’). Changes in wing chord over time were analysed using a repeated measures ANOVA and growth rates analysed with a linear mixed model (to control for hatching size). In 2004, ‘study’ chicks were smaller (F=1.17; p=0.0076) and grew more slowly (t=2.24; p=0.0365) than ‘control’ chicks to day 24. In 2005, the provisioning study began ~ day 42 and ‘control’ chicks grew significantly longer wings than ‘study’ chicks (F=1.84; p=0.0047), despite starting at the same length (F=0.769; p=0.094). In 2005, growth rates between the two groups were similar from day 1-24 (t=1.87; p=0.087) but ‘control’ chicks were growing faster by day 60 (t=5.56; p=0.001). Given the necessity of frequent handling of chicks during provisioning studies and the increasing use of and concern for bird-borne devices on adult Procellariiformes, our results strongly caution against both methods on the same active nest.

Addressing Aircraft Disturbance Issues in the Pribilof Islands, Alaska

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The Pribilof Islands support about 3 million nesting seabirds and about 600,000 breeding northern fur seals. The two major islands, St. Paul and St. George are also home to Unangan, the people also known as Aleuts. Both islands have airports with large paved runways, which receive flights almost daily. Aircraft buzzing nesting seabird cliffs and fur seal rookeries occur even during good weather by aircraft “sight-seeing” that result in disturbance. The following efforts have been taken to lessen wildlife disturbance: 1) Meetings with the Federal Aviation Administration (FAA) have resulted in FAA publishing flight advisories for St. Paul and St. George Islands; 2) Letters sent to commercial and U.S. Coast Guard (USCG) flight operations each spring advising them the issue of wildlife disturbance during their breeding season and the BASH (Bird Aircraft Strike Hazards) danger to aircraft; 3) The Ecosystem Conservation Offices for the Tribal Governments/Councils on both islands, through their Tanam Amgignaa (Island Sentinel) Program, watch for, document and report incidences when aircraft buzz seabird cliffs or marine mammal rookeries; and 4) A poster explaining the issue has been produced and will be sent to USCG and commercial airlines, and posted in appropriate airports this spring before wildlife breeding seasons commence. The poster is on display in the poster session.
Evaluating Parental Investment Strategies in Albatross – A Physiological Perspective

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The pattern of foraging trips made by Procellariiform seabirds during chick rearing allows us to investigate the parental tradeoff between self-maintenance and investment in offspring. Short trips are thought to provide frequent and consistent food for the chick at a net energetic loss to the parent. On the other hand, long trips may augment adult condition while the condition of the chick suffers by less frequent feedings. Parents should modulate the frequency and duration of these foraging trips to maximize lifetime reproductive success. We monitored all chick provisioning trips made by 27 adult Laysan Albatross (Phoebastria immutabilis) from hatching to fledging (Jan-July). We characterized individual variation in patterns of short (<5 day) and long trips and examined adult body condition and glucocorticoid physiology as potential mechanisms underlying this behavioral variation. Males and females did not differ in any aspect of provisioning behavior. Contrary to expectations, adults with higher condition at the end of incubation and lower percent condition loss during incubation performed a greater total number of long trips (thought to be the strategy of adults in lower condition) during chick rearing. We will also investigate glucocorticoid physiology in both the adults and chicks to gain a better understanding of the physiological factors affecting parental investment decisions.

What is Going on with the California Current? Changes in the Coastal Avifauna of Central Oregon over 13 Years

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A time series of nearshore abundance and productivity indices of selected species from vessel transects are compared with oceanographic parameters in a search for causality. Common Murres (Uria aalge), Pigeon Guillemots (Cepphus columba), and Marbled Murrelets (Brachyramphus marmoratus) showed discrete responses to marine conditions. Some migratory species such as Surf Scoters (Melanitta perspicillata) and Pacific Loons (Gavia pacifica) showed long term trends not related to regional marine conditions. A hypothesis of flux in the California Current is proposed.
Influence of Season and Age on Movements and Habitat Use of Short-Tailed Albatrosses: Implications for At-Sea Conservation

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Although we know Short-tailed Albatrosses (Phoebastria albatrus) occur along the North Pacific Rim, seasonal changes and age-specific differences in their distribution are poorly understood. Between 2002 and 2007, we satellite-tracked 35 Short-tailed Albatrosses during nearly all months (except December and January) and reproductive stages (except incubation and chick brooding). We integrated satellite tracking of albatrosses and oceanographic remote sensing data to identify physical and biological features of albatross foraging habitat. During chick-rearing, primary foraging areas included prominent chlorophyll and sea surface temperature fronts, generally within the 17°C isotherm off the continental shelf break and slope domains. Geographically, these areas were within 1,000 km of the breeding colony, a restricted foraging range compared to congeners breeding in Hawaii. During the non-breeding period, most short-tailed albatrosses traveled to Alaska’s Aleutian Islands, with more extensive movements into the Bering Sea occurring in mid-late summer and early fall. Compared to older birds, juvenile (< 1 year) short-tailed albatrosses exhibited marked differences in movement patterns and habitat use. Juveniles traveled twice the distance per day, were the only individuals tracked to the west coasts of Canada and the contiguous U.S., and spent more time within continental shelf habitat, than older age classes. Close proximity of the breeding colony to primary foraging grounds likely provides a buffer against fluctuations in foraging conditions, thereby supporting relatively high and consistent breeding success over the past decade. The contrasting broader dispersal of juvenile short-tailed albatrosses increases their potential interaction with a greater diversity of commercial fisheries.

†Contaminant Levels in Caspian Terns and Double-Crested Cormorants from the Columbia River Basin

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Caspian Terns (Hydroprogne caspia) and Double-crested Cormorants (Phalacrocorax auritus) nest in large numbers in the Columbia River basin, where elevated contaminant levels in other avian species and fish have been reported. In order to evaluate exposure of these piscivorous birds to environmental contaminants, we collected liver samples from Caspian Tern chicks and adults, as well as cormorant chicks from East Sand Island in the estuary and tern and cormorant chicks from nesting sites on the mid-Columbia River for analyses of selected metals and persistent organochlorine compounds. Contrary to expectation, Caspian Tern chicks from the mid-Columbia River revealed significantly higher concentrations of p,p’-DDE and total polychlorinated biphenyl (PCB) of 46 congeners compared to tern chicks from the estuary or cormorant chicks from either the estuary or the mid-Columbia River. Salmonid smolts represent more than two thirds of tern chick diets in the mid-Columbia River, while they represent significantly lower proportions in cormorant diets in the mid-Columbia River or tern and cormorant diets in the estuary. Because hatchery-reared salmonids have higher concentrations of environmental contaminants than their wild counterparts, the main contaminant exposure route for Caspian Tern chicks raised in the mid-Columbia River is likely hatchery-reared salmonids. Adult Caspian Terns from the estuary had higher concentrations of p,p’-DDE and total PCBs compared to tern and cormorant chicks from either study site. Levels of 19 metals, including mercury, lead, and selenium, were not sufficiently elevated in either species at either site to raise concerns over lethal effects.
Climate Change, Upwelling, and Seabird Dynamics in the Gulf of the Farallones

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In eastern boundary current systems, coastal upwelling is predicted to intensify as a result of increasing temperature gradients between land and sea. Along the U.S. west coast, atmospheric-oceanographic coupling in the past decade has been extremely variable, resulting in dramatic, unpredictable responses of the California Current large marine ecosystem. While global warming is predicted to cause increased upwelling in neritic environments, the potential effects on offshore regions is less clear (Bakun 1990). We investigated biological changes in neritic to offshore zones to test the hypothesis that global warming is differentially affecting these habitats. To test this hypothesis, we indexed primary/secondary productivity for the wide Gulf of the Farallones continental shelf ecosystem by comparing seabird population parameters and dynamics for inshore versus offshore foraging species. We found population, reproductive, and some dietary trends that appear consistent with the hypothesis of differential ecosystem changes in the Gulf of the Farallones depending on distance from the coast. This suggests that climate change is causing upwelling-ecosystem relationships to vary by distance from the coast, or that other oceanographic processes, e.g., circulation, may be driving differences in offshore and nearshore ecosystem productivity.

General Trends in Pelagic Forage Fish Abundance in the Strait of Georgia, British Columbia

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Pacific Herring (Clupea pallasi) are an important prey species for a variety of marine birds, mammals and fish. Adult herring can live 8-12 years and most mature at age-3, spawning on vegetation in the shallow subtidal or intertidal zone in early spring. In general, the amount of spawn has reflected stock abundance but local and regional changes in the timing and distribution of spawn have occurred, including cessation of spawning in some areas. As with other, pelagic, marine species, abundance has been highly variable over time. The Strait of Georgia stock has shown a sharp decrease in abundance since its historic high in 2003. Juvenile herring abundance also has been highly variable over the shorter time series available with a negative relationship between abundance and water temperature. Increased water temperature in recent years appears to be responsible for an observed shift in herring spawning patterns in the SOG with more spawning in the northern Strait and less spawning in the southern Strait and the mainland coast.

Another important forage species in the Strait is eulachon (Thaleichthys pacificus). Eulachon stocks collapsed coastwide in the early 1990s, prior to any type of stock assessment. The only stock in the Strait and the only one in BC that is assessed is the Fraser River stock. An egg and larval survey has been used since the mid-1990s to estimate spawning stock biomass (SSB) based on escapement. This stock remains at a precariously low level despite recent fishery closures with little sign of recovery.

Other forage fish such as Pacific sardine (Sardinops sagax), northern anchovy (Engraulis mordax), surf smelt (Hypomesus pretiosus) and Pacific sand lance (Ammodytes hexapterus) also are important in an ecosystem context. However, these species are not assessed within the Strait making it difficult to infer population trends. Anecdotal information suggests at least some of these species have declined in abundance in recent years. The potential implications of these trends will be discussed.
Oceanography of the Salish Sea

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The Strait of Georgia and Puget Sound constitute a highly productive and dynamically complex semi-enclosed sea that undergoes marked variability over a broad range of spatial and temporal scales of importance to seabird distribution and productivity. Bared to its essentials, the Salish Sea is a relatively shallow, glacially sculptured, stratified marine basin connected to the Pacific Ocean through a series of narrow tidal channels and into which is poured large volumes of fresh water draining seaward from watersheds in British Columbia and Washington State. The seasonally varying freshwater discharge, combined with strong diurnal and semidiurnal tidal currents generated through co-oscillation of the inner coastal waters with the open ocean, leads to a pronounced three-layer basin circulation and property structure with warm, brackish, high oxygen water on top and cold, salty, low oxygen water at the bottom. This structure is, in turn, modulated at fortnightly to interannual time scales by turbulent mixing and oceanic exchange processes within the connecting tidal channels. Regional winds can effect rapid changes in surface oceanographic conditions, including the structure and distribution of the Fraser River plume, while storm-force winds along the outer coast and major El Niño-La Niña events in the Equatorial Pacific can give rise to changes in the intermediate and deep water exchange of nutrients, dissolved oxygen and other water properties. Sea bird populations may also be affected by small scale surface convergences and divergences associated with internal waves emanating from the southern passes and by entrainment and mixing at tidal fronts and edges of river plumes. Recent non-governmental initiatives and government funded oceanographic programs such as STRATOGEM and the Strait of Georgia Initiative acknowledge the need to understand changes in the Salish Sea ecosystem in the light of accelerating human population growth and loss of marine and terrestrial habitat.

†The Behaviour of Marbled Murrelets (Brachyramphus marmoratus) in Response to the Corkline of a Modified Gillnet

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Bycatch poses a significant problem to many seabirds. In particular, coastal gillnet fisheries threaten many diving alcids such as the Marbled Murrelet (Brachyramphus marmoratus) due to the overlap of their breeding range and foraging habitat with commercial gillnet fisheries throughout British Columbia. Net modifications tested in other fisheries included high visibility mesh panels and drop weedlines. Little has been done within British Columbia to address seabird bycatch in gillnet fisheries. Additionally, the behaviour of Marbled Murrelets around gillnets is not well known. Do Marbled Murrelets actively forage in the presence of gillnet corklines? What is the behavioural response to the corkline? A larger mean proportion of murrelets were diving when within 10 m of the corkline (48.3%) than within 50 m (20%) suggesting that the corkline is influencing murrelet behaviour. There was no difference between frequencies of behaviours within 10 m, although 41% were observed diving close to the line showing that a large proportion of the observed birds would be at risk from entanglement. Murrelets took an average of 20.71 minutes to return to a net disturbed area. The data suggests that specific gear modifications or changes in fishery management could significantly reduce Marbled Murrelet bycatch.
Spatial and Temporal Scales of Variability in Seabird-Krill Interactions in the Antarctic

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We studied the dynamics of association between foraging Antarctic seabirds, mainly Chinstrap Penguins (Pygoscelis antarctica), Cape Petrels (Daption capense) and Wilson’s (Oceanites oceanicus) and Black-bellied Storm-Petrels (Fregetta tropica), during shipboard transects off the South Shetland Islands and Elephant Island, Antarctic Peninsula in 2001-2005. To quantify prey abundance, we supplemented the standard echosounders with a video camcorder that was attached to the echosounder frame. This enabled sampling at the immediate surface of the ocean. We found repeatability in the distributions of birds, krill and their association on the scale of 24 hrs and ~ 10 km. This finding supports the faithfulness with which shipboard transects represent the sampling the marine environment. At the same time, we found substantial differences between years. These differences seem related to broadscale variability in ocean temperature, ice coverage and krill abundance. We argue that measures of bird abundance, behavior and association with krill are metrics that can be used as indices of climate change.

Comparison of Newell’s Shearwater and Hawaiian Petrel Inland Flight Height Profiles on the Island of Kauai

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Adult and fledgling Newell’s Shearwaters (Puffinus auricularis newelli) and Hawaiian Petrels (Pterodroma sandwichensis) suffer substantial mortality due to the indirect effects of increased urbanization. During the spring and early summer months, adult Newell’s Shearwaters and Hawaiian Petrels travel in limited light conditions between inland cliff nest sites and open sea foraging locations resulting in occasional collisions with cars, power lines, and buildings. When juveniles fledge, they are often attracted to artificial light sources and circle until they “fallout” from exhaustion. Collision and fallout rates are quite variable across the island. In order to better understand the flight patterns that lead to these potential causes of mortality we used vertical and horizontal radar to record the heights and flight directions of the target species at four coastal locations on the island of Kauai. We tested for differences in flight height distributions between sites, between morning (seaward) and evening (inland) flights, and between the spring breeding season and the fall fledging season. In addition, we were able to directly compare traditional height estimation methods using an outside observer and heights derived from vertical radar. Significant differences were found between inland and seaward flight heights, as well as spring and fall flight heights, although the magnitude and direction of the differences varied between sites. Vertical radar estimated bird heights more accurately than an outside observer, providing complete height profiles with less daily variability.
Effects of the 1976 Regime Shift on Tropical Oceanic Seabirds: A Retrospective Isotopic Approach to Investigating Dietary Shifts Caused by Climate Variability in the Eastern Tropical Pacific

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An abrupt change in climatological conditions affected most of the eastern Pacific in 1976. Since this “regime shift”, the intensity and frequency of El Niño events in the Pacific has increased. It is hypothesized that the more frequent and intense environmental variability is responsible for prey depletion and/or altering the lower trophic prey base of high-order marine predators. Such effects are evident in temperate and polar ecosystems, while effects on top predators in oceanic tropical systems are not well known. Approximating trophic level of top predators by analyzing historically collected feathers, bones or teeth for δ15N and δ13C stable isotope values has proven to be an excellent approach to address this question. We isotopically examined contour feathers of seven seabird species from the two major feeding guilds (associating with subsurface predators or oceanographic features) and three avian orders (Procellariiformes, Pelecaniformes and Charadriiformes) of tropical seabirds. We compiled 349 total samples taken from specimens collected from 1955 to 2006 in the eastern Pacific warm pool; specifically: (Pterodroma externa) n=62, (Puffinus pacificus) n=64, (Oceanodroma leucorhoa) n=62, (O. tethys) n=51, (Sula sula) n=29, (Sterna fuscata) n=57 and (Anous stolidus) n=24. Differences in the temporal variability of δ15N and δ13C measurements will indicate if any change in trophic level and or foraging locations of these seabirds may have occurred. Results from this study address if the 1976 regime shift of the north Pacific affected top predators in the eastern tropical Pacific as strong as in temperate and polar systems of the eastern Pacific.

Individual Variation in Foraging Behavior Affects Food Provisioning Rate in Adelie Penguins

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Individual variation in foraging behaviour could be a proximate factor affecting offspring production. To understand the mechanisms that link foraging behaviour with food provisioning (frequency and mass of meals), nest attendance pattern and diving behavior of 20 Adélie penguin Pygoscelis adeliae pairs rearing chicks in a sea-ice area were monitored. Parents fed in small open waters surrounded by sea-ice mainly during 08:00 – 24:00 hr, because of ice forming on the sea-surface during 24:00-08:00 hr. Birds often departed from the colony in the afternoon making shorter trips, and hence brought back meals more frequently, than birds that made long over-night trips and birds that departed in the early morning. When the duration of the longest dive bout during each trip was longer, parents tended to bring back heavier meals containing larger krill. Birds diving deeper made longer dive bouts on average. Prey patch quality might be a key factor linking dive depth, bout duration and meal size. Thus, daily foraging pattern and dive bout duration affected provisioning rate but foraging intensity during the potential foraging period and total underwater time per day did not. Body condition did not affect provisioning rate. Normal food availability with predictable but limited feeding opportunity gave parents the potential to increase provisioning rate by selecting appropriate foraging time, foraging depth, and presumably foraging sites, without increasing foraging intensity or losing more own body mass.
Special Protection Areas for Marine Birds: The UK Approach

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Member states of the European Union have a legal responsibility under the Birds Directive to classify special protection areas (SPAs) in the marine environment for rare, vulnerable or regularly migratory bird species, which in the UK, include most seabird and many seaduck species. For this purpose, four different types of marine SPAs have been identified: (1) extending existing breeding colony SPAs into adjacent marine areas, (2) inshore SPAs for aggregations of seaduck, (3) offshore SPAs for areas that are important for foraging seabirds and (4) other types of SPAs, such as migration corridors. In addition to data from the existing European Seabirds at Sea (ESAS) database, new data, including targeted boat surveys, aerial surveys and radio-tracking, are being collected specifically to inform the process of identifying suitable SPAs within these four categories. This talk will highlight some of the issues with identifying protected areas for marine birds that may be common to those experienced in the Pacific, to give the opportunity for lessons to be learned on both sides.

Population Consequences of Ocean Climate Change for a Sensitive Climate Indicator the Seabird Cassin’s Auklet Ptychoramphus aleuticus

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Forecasting the ecological effects of anthropogenic climate change is critical for developing conservation strategies that increase population resilience under changing climate conditions. We examined the population consequences of ocean climate change in the California Current upwelling system on the planktivorous seabird Cassin’s auklet (Ptychoramphus aleuticus), a demographically sensitive indicator of marine climate change. We forecast changes in the population growth rate of the Cassin’s auklet population at the Farallon Islands, central California, using late 21st century climate projections from a regional climate model and relationships between auklet demography and oceanography developed from a long-term dataset. We also evaluated future ocean climate change across California auklet colonies. The Farallon Cassin’s auklet population growth rate decreased by 8%-49% when demographic rates were modeled as a function of sea surface temperature and by 0.5%-2.5% when modeled as a function of upwelling intensity, suggesting significant future population declines. Projected seasonal changes in upwelling timing and intensity varied across California colonies, indicating heterogeneity in future conditions for auklets. The Farallon auklet population has declined by ~6%/year during the past three decades and climate change will likely accelerate these declines. Conservation strategies for seabirds should increase population resilience by protecting colonies across the breeding range, reducing non-climate stressors, and facilitating movement and new colony establishment.
A Non-Invasive Approach in Understanding Population Variation of the White Tern (*Gygis alba*) in the Pacific


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Molted feathers, museum specimens, and freshly dead samples provided baseline data on genetic and morphological diversity among Pacific Ocean populations of White Terns. Populations were grouped by geography and taxonomic classifications: Northern Mariana Islands and Kwajalein Atoll (*Gygis alba candida*); Northwestern Hawaiian Islands (*Gygis alba rothschildi*); Tuamoto Archipelago and Kiribati (*Gygis alba pacifica*) and the Marquesas Islands (*Gygis alba microrhyncha*). Because of the recent colonization of Oahu Is. by individuals of unknown origin, this population was grouped separately. We used two mitochondrial genes, cytochrome b and NADH dehydrogenase subunit 2 and five morphological characters (culmen, culmen depth, wing chord, longest and shortest retrix) to evaluate White Tern subspecies designations within the Pacific Ocean. Mitochondrial markers were also used to determine the source population(s) of individuals from Oahu Is. Our preliminary results suggest that White Terns within the Pacific Ocean is comprised of one subspecies, populations of which share multiple haplotypes. However, there are significant genetic and morphological differences among populations, specifically among *G. a microrhyncha*, *G. a. pacifica*, and groups in the North Pacific. The Oahu population share haplotypes with all populations examined, which indicates that Oahu individuals come from multiple source populations. We recommend that *G. a microrhyncha* and *G. a. pacifica* be recognized as distinct management units, separate from populations in the North Pacific. Additionally, the Oahu population appears to represent a genetic mixture of individuals from populations throughout the Pacific Ocean and should be managed to preserve the maximum amount of genetic variability.

Chicks Raising Chicks: Successful Same Sex Pairing in Laysan Albatross

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Female-female pairing is rare in birds, with most cases occurring in socially monogamous species when the sex ratio was female-biased. Cooperative breeding, in which animals help raise offspring that are not their own, has often been explained by kin selection in cases where individuals were related, and by reciprocity where individuals were unrelated. Female-female pairing has not been reported in birds that lay a single egg. Previous reports of two egg clutches in albatross nests have been attributed to egg dumping. Here we show that unrelated female Laysan Albatross (*Phoebastria immutabilis*) will pair with one another and how this behavior may constitute an evolutionary stable strategy under certain conditions. We found that 29% of Laysan Albatross pairs on Oahu were female-female, and that the sex ratio was 57% female. This is the highest reported occurrence, and the first record of female-female pairing in the order Procellariiformes. Females in female-female pairs selectively mated with paired males despite unpaired males being available. Female-female pairs fledged fewer offspring than male-female pairs, but this was a better alternative than not breeding. Female-female pairs that raised a chick in more than one year had at least one offspring that was genetically related to each female, indicating that each female had an opportunity to breed. These results demonstrate that unrelated females can gain fitness benefits by pairing with each other and employing a reciprocity strategy when there is a shortage of males, and may explain other examples of two egg clutches in albatross.
Determining Spatial and Temporal Overlap of an Endangered Seabird with a Large Commercial Trawl Fishery

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Spatial and temporal overlap of short-tailed albatross (Phoebastria albatrus), an endangered species, and the Alaskan groundfish trawl fleet is influenced by the assumptions used to infer albatross distribution and differs among trawl sectors. Overlap is of concern because of the potential for incidental mortality. Due to the small size of this albatross population (ca. 2 000 birds) and their wide-ranging foraging behavior, opportunistic sightings contribute the majority of the data on their distribution. Two methods were used to predict distributions: (1) bounded interpolation of sightings and (2) distance to the 1 000 m isobath. The fishery was grouped into nine sectors based on fish processing mode and predominant product type. Locations and durations of observed trawls were associated with the predicted albatross densities. Establishing overlap lays the groundwork for research that would elucidate the factors responsible for interactions where overlap is known to occur and target mitigation of bycatch in a more efficacious manner. However, accurate assessment of bycatch requires knowledge of the nested interactions that lead from overlap to incidental mortalities.

Feather Imping: Fast Track to Flight

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Birds with broken feathers often sustain compromised flight or are unable to fly. Feather imping is a procedure in which broken feathers are repaired immediately using feathers from the same or another species with similar size feathers. A red-tailed tropicbird chick (Phaethon rubricauda) at Kilauea Point National Wildlife Refuge, Kauai, Hawaii, was unable to fly at time of fledging due to broken outer primaries as a result of fault bar development during an early starvation period. This paper describes the first successful feather imping procedure performed on this species with the replacement of portions of five primary feathers. Feather imping is a quick method of feather repair by which the bird can be released within 24 hours. It serves as an excellent alternative to holding the bird in captivity and possibly jeopardizing its chances of survival, particularly if the species does poorly in captive situations.
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