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SEABIRD AWARE PROJECT: REACHING MARINE STAKEHOLDERS AND BUILDING PARTNERSHIPS TO REDUCE THREATS TO SEABIRDS IN THE CALIFORNIA CURRENT SYSTEM [Poster]

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To encourage wise stewardship of our coasts and oceans in a time of increasing demands on marine resources, scientists and educators must provide the public with clear information about threats to marine ecosystems and science-based recommendations for improved stewardship. PRBO Conservation Science has initiated the Seabird Aware Project (www.prbo.org/seabirdaware) to encourage outreach partnerships and develop and disseminate educational resources among agencies, scientists and educators in the California Current System (CCS)—one of the world's most nutrient-rich ecosystems supporting millions of resident and migratory seabirds. Guided by The North American Waterbird Conservation Plan, the Seabird Aware Project seeks to provide relevant stakeholders, like fishers and boaters, with synthesized conservation recommendations to reduce threats to seabirds and marine habitats. Current threats addressed by the Project include human disturbance to breeding seabirds by too-close approaches to colonies, and the impact of bright lights on night-foraging and nesting seabirds.

TRACKING THE MOVEMENTS AND TRANS-PACIFIC MIGRATION OF SOOTY SHEARWATERS CAPTURED OFF CENTRAL CALIFORNIA

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Movements of pelagic seabirds while away from their breeding colonies are poorly understood. We initiated a post-breeding satellite-telemetry study off central California to investigate movements, habitat associations, and migration of the Sooty Shearwater (*Puffinus griseus*). To date, we have captured 97 birds off Santa Cruz and San Luis counties, and outfitted 20 subadult to adults with transmitters. Our primary objectives are to: (1) understand how satellite-tracked birds respond to variability in physical and biological properties in the ocean; (2) determine residence times within the California Current System; and (3) examine the timing associated with migration back to distant breeding colonies. Six birds captured during the molting period (June–July) remained within Monterey Bay and adjacent waters for 1–2 months, with one individual ranging as far north as Vancouver Island, Canada. An additional 14 birds were tagged in San Luis Bay in September 2004. We hypothesize that a lingering red tide in Monterey Bay might have caused large numbers of shearwaters to leave Monterey Bay. San Luis Bay and Pismo Beach were important destinations for birds tagged in Monterey Bay. As of 11 November 2004, 12 of 14 birds had crossed the equator. All flew directly toward New Zealand, and two flew towards South America after direct flight toward NZ. This study marks the first time researchers have tracked, in detail, the movements and incredible trans-Pacific migration of individual Sooty Shearwaters.

ASHY STORM-PETRELS IN THE CHANNEL ISLANDS NATIONAL PARK: POPULATION STATUS, ECOLOGY, AND NEW RESEARCH [Poster]

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The Ashy Storm-Petrel (*Oceanodroma homochroa*) is endemic to California Islands (including northern Baja California, México) and a few adjacent mainland sites. The estimated world breeding population is only 7,200 birds. Unlike most other storm-petrels, Ashy Storm-Petrel is non-migratory and resides within the California Current System year-round. Ashy Storm-Petrel currently is listed as “near threatened” by IUCN, is a Category 2 Candidate Species under the ESA, and is considered a Species of Management Concern. Natural-resource agencies realize an urgent need to assess current population numbers, trends, and basic ecology for Ashy Storm-Petrel. During 13 nights, we captured and banded 187 Ashy Storm-Petrels at Santa Barbara Island and 220 off Santa Cruz Island. Standardized Catch Per Unit Effort (CPUE) was 0.13 ± 0.06 birds min^{-1} (78 net hours). In the first study of its kind involving storm-petrels, we radio-marked 15 birds at SBI and 28 at SCI. Between 23 July and 23 August 2004, we flew 16 aerial tracking surveys and covered >72,000 km^2 of ocean. Storm-petrels were aggregated over the continental shelf-break from Pt. Conception to Pt. Reyes, within the Santa Barbara Channel, and within Monterey Bay, CA.

IS PARENTAL INVESTMENT BY RHINOCEROS AUKLETS FIXED OR FLEXIBLE?

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Parental investment strategies lie on a continuum between two extreme strategies of fixed versus flexible effort. In a fixed-effort strategy, a parent allocates a fixed amount of its time or energy budget to the current reproductive attempt, and so the chick pays the cost when food conditions are poor. In a flexible-effort strategy, a parent allocates time and energy to the reproductive effort to meet the demands of the chick, so the parent pays the cost of poor food conditions. We studied Rhinoceros Auklets breeding on Triangle Island, British Columbia, in 2003 (a poor food year) and 2004 (a good food year). We measured body condition and physiological condition (indexed by corticosterone stress response) of parents and growth rates and fledging parameters of their chicks to determine who was paying the cost when food conditions were poor. Body condition index of parent Rhinoceros Auklets was not different in the two study years. Baseline corticosterone was marginally higher and corticosterone response was significantly higher in 2003 than 2004. Chick fledging mass was lower in 2003 than in 2004. This indicates that chicks and parents bear some cost of poor food conditions, although parents appear to reserve some investment, as body condition was not compromised. Rhinoceros Auklets are less willing to increase investment in the current reproductive effort than do some other seabird species.

ONE FISH, TWO FISH, RED FISH, BLUE FISH: DO CASPIAN TERNS EAT THE SAME FISH THEY DELIVER TO THE COLONY? [Poster]

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Predation on ESA-listed juvenile salmonids (*Oncorhynchus* spp.) by Caspian Terns (*Sterna caspia*) in the Columbia River estuary prompted studies of tern diet composition utilizing identification of bill load fish on-colony. We compared diet composition based on bill-load identification with the composition of prey in stomach contents for Caspian Terns nesting at East Sand Island during 2001–2003 to determine if (1) terns eat a similar taxonomic composition of fish (foregut contents) as they deliver to mates or chicks (bill loads) and (2) terns feed mates a different taxonomic composition of fish than terns feed chicks. Bill loads were the same prey type as foregut contents in 69%, 78%, and 59% of the sample for 2001, 2002, and 2003, respectively (N = 61, 45, and 39, respectively). The frequency of salmonids in collected bill loads and foreguts was not significantly

different for any year ($P > 0.25$ for all years). During late incubation and early chick-rearing, when some terns fed mates and others fed chicks, the frequency of salmonids in mate feeds was similar to that in chick feeds in 2001 and 2003 (2001: $N = 344$, $\chi^2 = 1.53$, $P = 0.22$; 2003: $N = 321$, $\chi^2 = 0.13$, $P = 0.72$); however, in 2002 salmonids made up a greater proportion of mate feeds (66%) than chick feeds (54%) ($N = 329$, $\chi^2 = 4.87$, $P = 0.027$). There was little evidence that Caspian Terns selected different prey to feed mates and chicks than they consumed themselves.

VARIATIONS IN THE HOLOCENE COASTAL ANTARCTIC MARINE FOOD WEB: LINKING ISOTOPIC RECORDS OF SNOW PETREL MUMIYO AND MARINE PRODUCTIVITY [Poster]

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Laminae in sub-fossil deposits of Snow Petrel (*Pagodroma nivea*) stomach oil (mumiyo) were collected from nest-sites in the Bunger Hills, East Antarctica. Mumiyo layers and those in an ocean sediment core from nearby Dumont D'Urville Trough were radiocarbon dated and analyzed for $\delta^{13}\text{C}$ and δD . Ages ranged from about 10,160 to 526 calendar years before present (cal yr BP). Both mumiyo and sediment were enriched in ^{13}C during the warmer mid-Holocene (ca. 7500 to 5500 cal yr BP). Isotopic concordance between the core and the mumiyo, and a significant correlation between mumiyo δD and $\delta^{13}\text{C}$, suggests that past $\delta^{13}\text{C}$ variation in plankton was transferred through diet to higher trophic levels and ultimately recorded in Snow Petrel stomach oil. Periodic divergence in signals between the two samples may indicate a shift in foraging by the petrels from ^{13}C -enriched neritic prey during warmer periods to ^{13}C -depleted pelagic prey during cooler periods, a shift forced by presumed greater sea-ice concentration. Other air-breathing predators likely would respond in the same way.

RESPONSE OF TOP-TROPHIC SPECIES IN THE CALIFORNIA CURRENT TO THE RECENT SHIFT OF THE PACIFIC DECADAL OSCILLATION [Poster]

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Populations of certain seabird species in the north-central section of the California Current System (CCS) changed markedly during the last warm phase (1977–1998) of the Pacific Decadal Oscillation (PDO); with some exceptions, species with affinities for cooler water—especially local breeders—declined and warm-water species increased (Ainley & Divoky 2001, Hyrenbach & Veit 2003). In late 1998, the PDO apparently shifted to its cold phase, coincident with a very strong La Niña. Once the later event ended, changes in abundances of lower-trophic-level species consistent with a PDO shift became apparent beginning in about 1999 (e.g., Batchelder et al. 2003). Information on responses of top-predators to the PDO thus far has been lacking. Using an 18-year data set of annual cruises, 1985–2002, we tested the hypotheses that ‘visiting species’ in the avifauna would respond most immediately, as individuals return to the CCS after leaving during the warm PDO, and in year-round residents the response would be lagged as a function of productivity and their demographic parameters. The trajectories of most species changed with the PDO. Visiting species responded immediately (Sooty Shearwater, BF Albatross, Northern Fulmar), as did to a lesser extent the non-breeding portions of certain year-round residents (e.g., Cassin’s Auklet, Common Murre, Rhinoceros Auklet).

HERRING GULLS AND ACCESS TO COMMON EIDER EGG PREY: THE TERRITORIAL TRADE-OFF

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We observed gulls (*Larus argentatus*) occupying all-purpose territories within an eider (*Somateria mollissima*) colony in Canada’s Eastern Arctic. We mapped territories using locations of intra-specific agonistic encounters. We monitored territory attendance, rates of egg intake, and contribution to defence by males and females within each pair and quantified frequency and duration of territorial intrusions, likelihood of ensuing

chases, and rates of thievery. In the second of two years, we conducted a food-supplementation experiment on six individually marked pairs during 18 days of incubation. We hypothesized that, if time allotted by territorial gulls to territorial attendance is related to prey abundance within territories, then experimentally increasing prey quantity should lead to increased attendance. Females responded by increasing total time within their territory, both in incubation and non-incubation. Males reduced incubation time, but conversely increased non-incubation attendance. Intrusion duration and egg thievery occurred most often during absence of the non-incubating partner. We believe individuals in this system compensate for shortcomings in abundance of prey within their territories by foraging extra-territorially. However, this trade-off is modulated by the cost of increased prey depletion due to thievery by intruders occurring when territory “owners” are absent.

EFFECTS OF EMERGENT VEGETATION ON WAVE ATTENUATION AND ITS SIGNIFICANCE FOR OVER-WATER NESTING BIRDS

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Wind and wave action affects nesting success of many over-water nesting birds. Colonial grebes are particularly vulnerable to these factors, because they establish floating platforms within emergent beds. In Western Grebes (*Aechmophorus occidentalis*), wave action commonly accounts for over 50% of nest losses in colonies, and entire colonies may often be destroyed by major windstorms. Wave attenuation by dense emergent beds can be substantial, and survival of nest platforms in a colony of over 80 nests was related primarily to their distance from the exposed outer edge. In this study, we are examining factors important in predicting the degree of wave exposure that a nest platform experiences. These include water depth, fetch, wind speed, and density of submerged and emergent macrophytes. During the preliminary field season, we quantified maximal wave height and examined the dampening effects of different densities of bulrush (*Scirpus* spp.). These results have serious implications for management of waterbird nesting habitat. Our study site, Lake Christina, Minnesota, was treated with rotenone in October 2003 in an attempt to stimulate a trophic cascade leading to an increase in macrophytes. If successful, restoration of the aquatic vegetation may lead to an increase of waterbirds using the lake.

COMPONENTS OF REPRODUCTIVE IMPAIRMENT IN CONTAMINATED WESTERN/CLARK'S GREBES FROM CENTRAL CALIFORNIA

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In the mid-1950s, the insecticide p,p'-DDD was the major proximate cause of severely depressed populations of *Aechmophorus* grebes at Clear Lake, in central California. Today, some 50 years later, grebes have improved from the effects of DDD but still suffer reproductive impairments from a suite of proximate causes. Here, I evaluate the major multiple-stressors (organo-chlorines DDD and DDE, methyl mercury, habitat change, and disturbance) and I estimate their relative roles. Since DDD is not converted to DDE in natural systems, DDE must originate from the past use of DDT. Clear Lake grebes still suffer chronic DDE-induced eggshell thinning, but DDD levels, although still present as a distinct “Clear Lake fingerprint”, are probably no longer important toxicologically and have declined by several orders of magnitude in all ecosystem components measured. Methyl mercury, now known to have been present in Clear Lake grebes even during earlier DDD studies, is declining, but some levels are still close to those that have effects on developing embryos and adult liver function. Yet, human disturbances in the last ten years have by far been an over-riding factor depressing reproduction. The suite of stressors has resulted in a chronically low negative effect on reproduction at comparison sites, so that Clear Lake is still a “sink” relative to “source” populations at Eagle Lake and Tule Lake, in northern California.

SEABIRD RESTORATION PROJECTS TO COMPENSATE FOR THE 1998 *COMMAND* OIL SPILL [Poster]

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Through the restoration provisions of the federal Oil Pollution Act and California Oil Spill Prevention and Response Act, Trustee agencies will implement seven seabird restoration projects to compensate for seabird impacts from the 1998 *Command* oil spill. The spill occurred just off the coast of San Francisco, and several seabird species and thousands of individual birds were injured by the spill. The Trustees have developed a restoration plan and will implement the following seabird projects: acquisition and enhancement of Marbled Murrelet habitat, corvid management at local and state parks to benefit nesting Marbled Murrelets, regional protection of seabird colonies, Common Murre nest-ledge creation, Brown Pelican roost site enhancement and creation, education regarding Brown Pelican entanglement at fishing piers, and rat eradication in New Zealand to benefit Sooty Shearwaters. We will discuss the regulations that make it possible to compensate for oil spill injuries to seabirds and will present the restoration projects in detail.

FORAGING ECOLOGY AND FISHING INTERACTIONS OF GREY-HEADED AND BLACK-BROWED ALBATROSSES AT THE DIEGO RAMIREZ ISLANDS, CHILE

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The foraging ecology and status of the Grey-headed and Black-browed albatrosses at Diego Ramirez (56°31'S, 68°44'W), Chile, is described. Both albatross species showed marked differences in their foraging areas during breeding, which were reflected in their diets and provisioning patterns to chicks. These differences result in contrasting population status and interactions with local long-line fisheries between these sympatric species. Feeding on pelagic squids, Grey-headed Albatrosses have low interaction with local fishing vessels, which occurs mostly on the continental shelf and slope, and their breeding success depends strongly on the natural variability of their main prey. In contrast, Black-browed Albatrosses depend heavily on fishing offal discards during the chick rearing, which seems to positively affect their breeding performance. As expected, Black-browed Albatrosses are the main (96%) species caught incidentally on the long-line fisheries in southern Chile. The final output of these two contrasting effects of the fishery is explored. A strong reduction in the fishing effort during the last decade seems to be correlated with a recent increase of the Gonzalo Island population (at Diego Ramirez). A longer census data set, together with better estimates of survival and breeding success, is needed to explain these contrasting effects.

AVESMODELER: UNDERSTANDING THE IMPACTS OF OIL DEVELOPMENT ON MARINE BIRDS [Poster]

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Natural resource managers charged with assessing the potential impacts of oil spills or determining the level of damage from an oil spill to marine birds need a suite of tools with which to develop their assessment. Multiple tools exist to identify acute losses and project the trajectories of spilled oil, but assessing population-level impacts is more difficult. Often, data are limited or difficult to collate in the timeframe available. Even when data are available, understanding population-level impacts often requires complex modeling, frequently beyond the scope of the individual charged with the assessment. In 2001, in collaboration with the USGS Alaska Science Center and Minerals Management Service, we began a project to develop a user-friendly database and modeling software program and demonstration models for 29 target species. The database is easy to search and contains a complete literature review for 29 North Slope (Alaska) waterbird species. It includes data in tabular format, detailed notes, and PDFs. Use of the modeling software requires minimal background in matrix population models and no background in programming. The output includes complete demographic analysis relevant to assessment of the impacts of oil-related catastrophes on marine birds. It is designed to be flexible to model a wide range of species, including birds, invertebrates, or plants.

EGG RESCUE INCREASES HATCHING SUCCESS IN MOBILE-INCUBATING WAVED ALBATROSSES
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Waved Albatrosses (*Phoebastria irrorata*) often relocate their eggs during incubation. This behavior frequently results in eggs becoming lodged between rocks and accounts for 10–80% of breeding failures. As albatross populations worldwide are currently threatened, artificial means of augmenting reproductive success may be necessary to maintain stable populations. We characterize the frequency and extent of egg movement; test several hypotheses related to microhabitat, timing, and location to explain causation of the behavior; and investigate the utility of repositioning lodged eggs to a location where breeding birds might resume incubation. Egg rescue increased both the likelihood of continued incubation and hatching rate in our experiment and provides an efficient, low-cost management option for Waved Albatrosses.

GEOGRAPHIC STRUCTURE AMONG SOOTY SHEARWATER POPULATIONS FROM THE EASTERN AND WESTERN PACIFIC OCEAN USING MITOCHONDRIAL DNA

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In this study, we examined population structure and gene flow of Sooty Shearwaters in the Pacific Ocean to understand migration patterns and recent declines in population numbers better. Population structure was analyzed by sequencing two mitochondrial regions, cytochrome b (*cytb*) and control region (*mtcontrol*) among 8 populations, including 3 island populations from New Zealand (Putauhinu, Pikomamaku, and Taukihepa), 4 samples from Chile (Valparaiso, Morton Diego, Chiloe, and Guafo), and 1 sample from Monterey Bay, California. Except for Valparaiso and Monterey Bay, all samples were collected directly from breeding colonies. The Monterey Bay sample was taken from migrating individuals, and the Valparaiso sample was taken from beachcast birds or from birds taken at sea. We found moderate population structure using *cytb*, with 25% of total molecular variation explained by differences between New Zealand and Chilean populations. Guafo Island, Chile, was genetically distinct from all other locations except Chiloe Island located nearby. Using the *mtcontrol* region, we found similar results as the *cytb* marker, with moderate gene flow among populations within New Zealand and Chile. Surprisingly, Valparaiso had equally similar genetic distances to the New Zealand populations as to Chilean populations. The shearwaters sampled in Monterey Bay had significantly different molecular distances from all New Zealand populations and Guafo Island, Chile, but contained haplotypes that were both common in New Zealand and rare in Chile and *vice versa*. It is likely the birds captured in Monterey Bay and Valparaiso contained a mix of individuals from both sides of the Pacific Ocean.

NESTING HABITAT CHARACTERISTICS OF MARBLED MURRELETS IN CENTRAL CALIFORNIA
[Poster]

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In this study, we (1) described habitat characteristics at 17 Marbled Murrelet nest sites in the Santa Cruz Mountains, California, located using radio-telemetry and visual searches; and (2) identified potentially important habitat characteristics by comparing nest sites with random sites centered on old-growth trees (PNTs). All 17 nests were located in stands of old-growth coast redwood–Douglas fir forests; of these, 13 (76%) were in parks and 4 (26%) were on private property. Fourteen nest sites (82%) were in unharvested stands, and 3 sites (18%), all on private property, had been selectively harvested. Harvested nest stands retained a component of residual old-growth trees (4–6 trees ≥ 120 cm DBH/25-m radius plot) and did not contain significantly fewer trees ≥ 120 cm DBH than unharvested nest stands. All 17 nests were found in old-growth coniferous trees (mean DBH = 210 cm, SD = 91); of these, 7 (41%) were in redwood trees and 10 (59%) were in Douglas fir trees. Twelve of

15 (80%) nests for which we were able to locate the nesting platform were on limbs, and 3 (20%) nests, all in redwood trees, were located on broken tops. Murrelet nest trees were larger than PNTs, and nest sites were located closer to streams, had a greater basal area of trees ≥ 120 cm DBH, had a greater basal area of redwood trees ≥ 120 cm DBH, and were located lower on slopes. Our results suggest that management plans in the Santa Cruz Mountains should protect and promote the regeneration of stands of old-growth redwood–Douglas fir forest.

AT-SEA DISTRIBUTION AND ABUNDANCE OF SEABIRDS IN HAWAIIAN WATERS

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In summer and fall of 2002 (July–November), we conducted a seabird survey of Hawaiian waters from two NOAA research vessels using standard 300-m strip transect methods. Our study area included the EEZ (out to 200 nautical miles) of the entire Hawaiian Archipelago, composing approximately 2.5 million km² of water. We recorded 40 species and estimated a total abundance of approximately 6 million birds. Local breeders accounted for half of the species (20) and 67% of the total birds, whereas seasonal visitors and migrants made up the other half of the species (20) and 33% of the birds. Nearly all of these were of one order (Procellariiformes), while the diversity at the genus, family, and order level was significantly higher for local breeders. For most species breeding during the survey, at-sea distributions reflected the locations of their breeding colonies. At least 6 local breeders forage outside of Hawaiian waters during their breeding season or leave Hawaiian waters when not breeding; this was evident in their at-sea distributions. Finally, distributions of seasonal visitors indicated potential associations with island wakes and at-sea segregation between these species and local breeders. The areas of highest density were localized in waters between Laysan and Kure, whereas areas of highest diversity were localized around Laysan, Lisianski, and Kauai.

FATTY-ACID ANALYSIS IN SEABIRDS: SLIMMING-DOWN TECHNIQUES FOR DIET ASSESSMENT

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The foraging behavior of seabirds is difficult to observe, and the sampling methods used to infer dietary intake in these animals are often inaccurate, imprecise, or highly invasive. Fatty-acid analysis of adipose tissue has been recently used to accurately determine diet composition for seabirds. Our aim was to test whether the less invasive approach of using blood-serum fatty acids would also accurately reflect known diets in Black-legged Kittiwakes (*Rissa tridactyla*) and how serum fatty acids compare to the fatty acids deposited in the adipose tissue. We collected adipose tissue and blood serum at regular intervals from 11 captive kittiwake chicks fed two known diets. Although fatty-acid signatures differed between adipose tissue and blood serum, we easily were able to distinguish between the two diet groups with both tissue profiles. Our results suggest that blood serum is a viable and practical source of fatty acids for dietary analysis in seabirds. Its use is particularly recommended for studies involving species that are sensitive to prolonged handling.

WITHIN- AND BETWEEN-SEASON CHANGES IN BODY COMPOSITION OF FORAGE FISH NEAR TRIANGLE ISLAND, BRITISH COLUMBIA: IMPLICATIONS FOR RHINOCEROS AUKLET PRODUCTIVITY [Poster]

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Little is known about the energy content of forage fish in British Columbia, how it changes within and between species and seasons, and what effects variability may have on seabird productivity. To investigate these questions, we determined diets of Rhinoceros Auklet (*Cerorhinca monocerata*) chicks and body composition of prey during two breeding seasons at Triangle Island, British Columbia. We also monitored reproductive success of Rhinoceros Auklets over this same period. Reproductive success in 2004 (0.66

fledglings/pair) was higher than in 2003 (0.35 fledglings/pair). Pacific saury (*Cololabis saira*) and Pacific sand lance (*Ammodytes hexapterus*) dominated 2003 diets, whereas rockfish (*Sebastes* spp.), sand lance, and salmon (*Oncorhynchus* spp.) dominated in 2004. Preliminary results for 2003 show no significant within-species change in energy densities over the breeding season. The mean energy content of saury (59.1 kJ/fish +7.4 SEM.), a pelagic species, and sand lance (69.8 kJ/fish +7.4 SEM.), an inshore species, were not statistically different, although this may have been due to low power ($P = 0.3845$). While many other factors influence foraging efficiency, these results do suggest that saury require birds to travel farther to obtain lower-quality prey. The importance of prey energy content to Rhinoceros Auklet productivity will be further clarified with the analysis of 2004 data.

FORAGING ECOLOGY OF BLACK-CROWNED NIGHT-HERONS IN THE NEW YORK CITY AREA

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Over 1,700 pairs of colonial wading birds (e.g., herons, egrets, ibises) breed and forage in the industrialized ecosystem of metropolitan New York City. Wading-bird colonies are located on seven islands that lie between western Staten Island and Long Island Sound. The Black-crowned Night-Heron (*Nycticorax nycticorax*), a mainly nocturnal forager, is the numerically dominant breeding wader in these colonies and has been undergoing population declines, both locally and region-wide. My objective was to determine how Black-crowned Night-Herons use marine, freshwater, and terrestrial environments in this highly urbanized setting. From March to September 2004, I conducted weekly surveys on Staten Island, NY, to describe (1) *N. nycticorax* night-time abundance and foraging success in four habitat types (shoreline, salt marsh, freshwater, terrestrial); and (2) *N. nycticorax* foraging flight patterns from an active breeding colony. In 2004, I observed a mean of 54 Black-crowned Night-Herons/week foraging at 35 sites on Staten Island. I found that: (1) a tradeoff existed between habitat type and foraging success; (2) individuals used different foraging techniques in different habitats; (3) activity level remained constant over the entire night cycle; and (4) the most abundant prey items available at foraging sites also made up the largest proportion of food provisioned to nestlings. By describing habitat use and foraging success for *N. nycticorax* and developing techniques to establish a direct link between individuals and their shifting use of foraging habitats, comprehensive conservation and management plans for local wader populations can be developed.

MANAGEMENT OF MARBLED MURRELET POPULATIONS UNDER CANADIAN LAW AND POLICY

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The Marbled Murrelet is listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as "Threatened" due to nesting habitat loss and threats of mortality from oil and gill net fishing. In 2003, Canada passed the Species at Risk Act (SARA). The act identifies listed species as Extirpated, Endangered, Threatened or Special Concern, outlines prohibitions, and requires recovery strategies and action plans to be produced. The SARA focuses on the identification and conservation of "critical habitat" as the basis for recovery of listed species. The SARA places emphasis on land stewardship and delegates responsibility for conservation of species on non-federal lands to the provinces and territories of Canada. The SARA has a "safety net" which can be invoked if it can be demonstrated that a province or territory has failed to protect a listed species adequately. In British Columbia, the provincial Wildlife Act and the Forest Practices and Range Act address wildlife conservation. However, the BC Forest Practices Review Board has criticized the policies to conserve Marbled Murrelet habitat in BC on two recent occasions. The Canadian Marbled Murrelet Recovery Team provides scientific advice to the federal and provincial Ministers and is responsible for producing a Recovery Strategy and Action Plans. We contrast the conservation of Marbled Murrelets under the Canadian Species at Risk Act with the Endangered Species Act in the USA.

POWER TO DETECT TRENDS IN MARBLED MURRELET POPULATIONS USING AUDIO-VISUAL AND RADAR SURVEYS

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We used pilot data collected in 2001–2004 to compare the power of radar and audio-visual survey approaches to detect trends in breeding population size and differences in trends between populations of Marbled Murrelets (*Brachyramphus marmoratus*) in northwestern California. Audio-visual counts were much more variable than radar counts overall (CV = 1.10 vs. 0.41) and within survey sites (CV = 0.94 vs. 0.23). Power to detect trends was considerably greater for the radar than for the audio-visual method. For example, relatively small (2.5%) annual declines could be detected in 10 years with reasonable power (>80%) by surveying 22 radar sites 4 times per year. To achieve an equivalent level of power, 40 audio-visual sites would need to be surveyed 4 times per year. A monitoring program designed to detect differences in trends between breeding murrelet populations required greater survey effort than a program designed to detect overall trends. The estimated annual cost of achieving equivalent power was similar between survey methods. Power to detect trends in murrelet populations was most sensitive to the duration of the monitoring program and the magnitude of the trend; only relatively modest gains in power were realized by increasing the number of surveys or sites. Given that power to detect trends and differences in trends was lower for audio-visual than radar surveys and that radar counts reflected annual changes in breeding population size, we recommend the use of radar to monitor inland populations of Marbled Murrelets and to estimate the effect of land management on local populations.

DIET DYNAMICS OF LAYSAN AND BLACK-FOOTED ALBATROSSES IN RELATION TO PELAGIC FISHERIES

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We are investigating the extent to which Laysan and Black-footed albatrosses rely on fisheries for food resources, whether there are annual or seasonal differences in fisheries reliance, and what effects, if any, there are due to changes in fishing practices. We address these questions through a combined digestive-tract content analysis and a muscle and liver stable-isotope analysis of albatrosses salvaged from pelagic longline fishing vessels and from albatross breeding colonies, accompanied by re-examining data collected by Gould et al. from birds salvaged between 1991–1993 from high-seas drift-net vessels. Preliminary results suggest a strong fishery component in the diet of both species, despite the demise of high seas drift-net fishing.

BREEDING-SEASON MOVEMENTS OF RADIO-TAGGED MARBLED MURRELETS IN THE STRAIT OF JUAN DE FUCA, WASHINGTON [Poster]

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We radio-tagged 27 Marbled Murrelets in the Strait of Juan de Fuca during the breeding season of 2004 to monitor inland and marine movements associated with breeding. Birds were tagged in the Washington waters of the central part of the Strait between 26 April and 11 July. We used aerial and ground-based telemetry to estimate murrelet locations on a daily basis and obtained an average of 24 at-sea locations per bird (range = 5–57). Most murrelets ($n = 17$) were found on every survey attempt, while the remainder were found between 83–96% of the time. Nine murrelets were detected inland at least once. We confirmed three breeding attempts and found each nest in old-growth trees in Olympic National Park. We also suspect three other nesting attempts based on movement behaviors, but we tagged the birds too late to find the nests. At-sea spatial use was generally predictable until mid-June, when radio-tagged murrelets began leaving the study area. Fifteen birds left the area, and only four were later found during opportunistic flights in distant areas from the outer coast of Washington to northern Vancouver Island. This apparent movement of Marbled Murrelets out of the Strait of

Juan de Fuca during the middle part of the breeding season is supported by our line-transect surveys conducted from 2000–2004.

FLIPPER-BANDING MAGELLANIC PENGUINS: DO BANDS REDUCE SURVIVAL?

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We double-banded 150 pairs of breeding Magellanic Penguins in 1993 (during egg-laying or early incubation), using three types of individually numbered identification. We double-marked individuals with either a band on each flipper or two web tags on the web of the foot. Pairs were double-banded with aluminum bands made by Gey Band and Tag Company ($n = 50$) or with stainless-steel bands made by Lambourne ($n = 50$) or were web-tagged with two stainless-steel mouse 005-ear tags 1 cm long and 2 mm wide, made by National Band and Tag Company ($n = 50$). Nests were individually and permanently marked within a 50-m² area to facilitate thorough searching. Two to six people searched in and around the area, looking for marked birds four to five times each year between October 1993 and February 2004. By January 1994, several aluminum bands were 1 mm open, and eight penguins with aluminum bands were dead. Clearly, all bands are not equal. In the 2003–2004 season, we checked the area 4 times between October and February and found 13 penguins with double stainless-steel bands, 9 males and 4 females, and 18 web-tagged penguins, 9 males and 9 females. After ten years, double-banded breeding penguins had a 13% survival rate, and double web-tagged penguins 18%, which was not significantly different ($\chi^2 = 0.49$, $P = 0.48$). A Cox proportional-hazards test showed that female double-banded penguins had significantly lower survival than web-tagged females ($P = 0.03$).

VEGETATIVE AND HYDROLOGICAL INFLUENCES ON ARDEID COLONY SITE SELECTION

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Availability of prey and avoidance of predation are both important factors affecting wading-bird breeding success. We investigated whether vegetative and hydrological variables affecting these processes influenced breeding-colony site selection of four ardeid species in the Florida Everglades between 1993 and 2000. Using the Akaike Information Criterion, we chose the logistic regression model for each species that best distinguished between used locations and an equal number of randomly-chosen, unused potential locations. The amount of foraging habitat around potential colony sites was a component of the best model for each species. Contrary to our predictions, water depth variability and/or the likelihood of water depths declining throughout the breeding season had a negative relationship with site selection for three of the species. These results illustrate that ecological variables might play multiple functional roles. If hydrological variables represent foraging opportunities or constraints, as we originally assumed, then our results suggest that herons are not as dependent on hydrological concentration of prey (the "falling water" paradigm) as other wading bird species. Alternatively, stable hydrological conditions might be a cue for predator avoidance, and this might be a stronger driver for colony site selection than foraging opportunities. In either case, these results call into question whether wading birds respond to environmental cues as predictors for future conditions or simply respond to present conditions.

BREEDING PROPENSITY OF HARLEQUIN DUCKS: A NOVEL APPROACH USING RADIO TELEMTRY AND YOLK-PRECURSOR ANALYSIS

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There has been a general assumption that a considerable proportion of adult female Harlequin Ducks on breeding streams are nonbreeders, although data to support or refute that assumption are few and methodologically flawed. Failed breeders, especially those that fail early, are difficult to distinguish from nonbreeders; therefore, estimates of nonbreeding females very likely include some proportion of failed nesters. We employed a novel approach of combining information from radio telemetry and yolk precursor (vitellogenin) analysis to address this issue. In our study, telemetry was likely to misclassify breeders that failed early (21%), and yolk precursor analysis misclassified breeders captured outside of the egg-formation period,

although this was rare (3%). Using both methods, we estimated that breeding propensity in Harlequin Ducks that migrated to breeding streams was 92%, the highest estimate reported to date. These data lend important insights into life-history strategies and sources of constraints on productivity of Harlequin Ducks. Further, these methods can be applied to other species to derive unbiased, quantitative rates of reproductive effort.

A TEST OF SOME POTENTIAL BIASES WHEN USING STRIP-TRANSECT METHODS TO SURVEY SEABIRDS IN TROPICAL WATERS [Poster]

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Two survey methods for counting seabirds were employed simultaneously and independently on research cruises in the eastern tropical Pacific Ocean (ETP): (1) a 600-m strip quadrant was surveyed on one side of the bow using 8 x 40 binoculars (strip transect) and (2) birds were surveyed from the bow to the horizon on both sides of the ship using 25 x 150 mounted binoculars ('big-eyes'). Data collected using each method were compared to determine potential biases of the strip-transect methods, with particular attention paid to seabird ship avoidance. Seabird species were assigned to five categories to control for detection biases resulting from differences in body size and behavior, and comparisons between methods were made within each of these categories. Our results indicate that frigatebirds (*Fregata* spp.), Sooty Terns (*Sterna fuscata*), and White Terns (*Gygis alba*) may avoid ships; therefore, unless compensatory procedures are taken, estimates of density and abundance of these species using strip transects may be negatively biased.

MARINE BIRD ABUNDANCE CHANGES IN NW WASHINGTON INSHORE WATERS

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Northern Puget Sound marine bird abundance was first assessed in the 1978–1979 Marine Ecosystems Analysis Puget Sound Project (MESA). The Puget Sound Ambient Monitoring Program's (PSAMP) aerial surveys have provided the only comprehensive indication of subsequent abundance changes, reporting declines for many species. In our two-year study, we determined abundance changes by censusing monthly from 125 MESA land-based sites and three ferry runs. Preliminary results indicate a 41% decrease in marine birds since the 1970s, including decreases of greater than 20% in 25 of the 35 species most common in the late 1970s. These include Western Grebe (–81%), Red-necked Grebe (–59%), Brant (–82%), Surf Scoter (–40%), scaup (–61%), Common Murre (–91%), and Marbled Murrelet (–51%). Species showing increases include Pigeon Guillemot (+50%) and Double-crested Cormorant (+50%). These results largely agree with PSAMP results, signaling increased concern over NW Washington marine bird abundance. Our study also allows detection of small-scale geographic variation in abundance changes. Marbled Murrelets, for instance, decreased 98% in 33 of our 35 census routes but increased dramatically in the other two. We use our results as environmental indicators for specific bodies of water and to suggest critical sites for conservation work.

A SEABIRD CONSERVATION EDUCATION AND OUTREACH PROGRAM [Poster]

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Most recreational anglers interact, at some point, with seabirds while fishing along our coast. Seabirds may eat the same fishes being targeted or may be attracted to bait at the end of fishing lines and, as a result, can be accidentally hooked or entangled. Both hooks and broken lines injure and kill seabirds. Hooks penetrate the bird's hollow bones and lead to infection. Fishing line may wrap around bird's wings, legs, or beaks and result in death due to starvation. Seabirds also face threats from the public's growing interest in coastal recreation activities such as kayaking and boating. These activities have resulted in increased disturbance to roosting and nesting areas. To address these threats, the *American Trader* Oil Spill Trustee Council (U.S. Fish and Wildlife

Service, National Oceanic and Atmospheric Administration, and California Department of Fish and Game), in cooperation with the Channel Islands National Marine Sanctuary, implemented a Seabird Conservation Education and Outreach program for the Santa Barbara and Ventura, California, area. The goal of the program is to provide information in the form of brochures and signs that will increase public awareness about threats to seabirds of the Channel Islands and Santa Barbara Channel and ways to reduce human impacts on this resource. The *American Trader* Oil Spill occurred in 1990, when that tanker spilled approximately 400,000 gallons of oil into the Pacific Ocean offshore of Huntington Beach. A \$3 million settlement to restore injured seabirds was reached with the responsible parties in 1994.

ENCOUNTER, SURVIVAL, AND MOVEMENT PROBABILITIES FROM AN ATLANTIC PUFFIN METAPOPOPULATION

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Virtually all animal species persist as metapopulations, i.e., two or more local populations connected through dispersal. However, due to prevalence of single-site over multi-site research, weaknesses in our understanding of long-lived animals persist, including few rigorous estimates of dispersal and immature survival. We performed a mark-resight analysis using 2,050 Atlantic Puffins (*Fratercula arctica*) banded as chicks on four colonies over 24 years in the Gulf of Maine, USA, and Canada. Using models built in program MARK, we performed several exploratory and hypothesis-driven tests to identify the importance of several model factors and produce estimates of demographic parameters and encounter probabilities. Demographic parameters measured were: apparent survival; pre-breeding movement (annual, pre-breeding, inter-colony movements); and natal dispersal. Temporal variation in encounter probabilities was strong (0.20–0.95). Colony-independent survival estimates increased to age five (0.88) then declined (0.69), possibly due to worn bands or lower survival of non-breeding adults than breeders. Natal dispersal and, consequently, philopatry was colony-dependent (0.08–0.25). Consistent with conspecific attraction, pre-breeding movement probabilities were considerably lower for large versus small colonies. Our results suggest that multi-site studies are necessary to measure accurately demographic parameters and their contribution to local population dynamics.

INTERANNUAL DIFFERENCES IN ADRENAL RESPONSIVENESS OF BLACK-LEGGED KITTIWAKE CHICKS

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Seabird productivity is considered an effective measure of food abundance in marine systems. Seabirds respond physiologically to decreased food availability by increasing plasma concentration of corticosterone to promote individual survival. High concentration of plasma corticosterone in chicks promotes increased begging and is known to impact metabolic pathways to facilitate increased metabolism of lean tissue. In Chiniak Bay, Alaska, we monitored productivity (fledglings/nesting attempt) of Black-legged Kittiwakes (*Rissa tridactyla*) and sampled chicks for blood at 3, 10, 30, and 50 minutes post-capture in 2002–2004. Corticosterone levels were subsequently determined by radioimmunoassay. Productivity was greatest in 2002 (0.45) and progressively decreased to 0.24 in 2003 and 0.01 in 2004. Nestling status had no significant effect on adrenal responsiveness, but adrenal responsiveness corresponded inversely with productivity. Chicks had significantly higher corticosterone concentrations in 2004 than in 2002 and 2003 at both 30 minutes ($F = 3.38$, $P = 0.0134$) and 50 minutes ($F = 8.56$, $P < 0.001$) post-capture. Thus, chicks in a low-productivity year exhibited both a more profound increase in corticosterone and a slower return to baseline, indicative of chronic stress. This study provides support for using corticosterone concentration of Black-legged Kittiwake chicks as an index of food availability.

WING SHAPE AS CORRELATED WITH FLIGHT BEHAVIOR IN PELECANIFORM SEABIRDS

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Tropical seabirds often traverse great distances in search of prey; therefore, selection on wing morphology is likely to be intense. Wing morphology of five pelecaniform species from Johnston Atoll was analyzed to determine how wing size and shape correlate with observed foraging behavior. Digital photos of wings were used to compute aspect ratio and wing loading for a species comparison. To explore more subtle shape differences, landmarks were created on the digital photos and analyzed using the Thin-Plate Spline-Relative Warps program. This analysis summarizes variation in the positions of each landmark into composite variables called relative warps, thereby providing a more detailed view of shape differences throughout the entire wing. Significant differences were found among species with regards to the wing base, curvature of the mid wing, and size/shape of the distal wing. Significant differences were also found between sexes of the Great Frigatebird, but not the Brown Booby. In the case of the Red-tailed Tropicbird, explanations are suggested that may help explain why this species deviates from predicted wing loading and aspect ratio. Differences in wing shape can be correlated with feeding and foraging ecology for most of these species. Future analyses incorporating more species will help us to understand the evolution of wing shape among seabirds as they radiated to utilize oceanic resources.

PENGUINS WALK A STRAIGHT LINE UNLESS DISORIENTED

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We followed 105 Magellanic Penguins (*Spheniscus magellanicus*) at Punta Tombo, Argentina, as they returned to their nests and recorded their GPS positions along the route. Some penguins walked nearly 1 km to reach their nest, and their routes were highly directional. We measured straightness by plotting the GPS coordinates in decimal degrees on an X–Y graph for each penguin and used the r-value to determine straightness (average r for all areas is 0.980, $n = 82$ routes with more than 4 coordinates used). In areas with obstacles (e.g., large, dense bushes), penguins take longer to arrive at their nest than in unobstructed areas. Penguins passing through the area with the most obstacles had a significantly slower average speed of 0.247 m/s than penguins that walked through two areas that had small bushes (average speed = 0.318 and 0.327 m/s), (ANOVA: $F = 10.86$, $df = 2, 74$, $P < 0.0001$). We also displaced 30 blindfolded penguins 50, 100, and 200 m from their entry point into the colony to determine if they followed a straight line to their nest. Moving penguins even 50 m caused disorientation. Penguins that were displaced looked around with their necks extended for a longer period of time than penguins that were held but not moved. Apparently, they were looking for which way to go. After being displaced, some penguins walked in the direction of where they had entered the colony and, as soon as the bird reached its usual route, it turned 90 degrees and walked in a straight line to the nest.

WADING-BIRD MIGRATION THROUGH CENTRAL TURKEY: 2004 VS. 1988

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We studied migratory and other waterbirds using wetlands in Kayseri Province, central Turkey, during March–May 2004. Study areas were the Sultan Marshes and other closed-basin wetlands. Common waders included Ruff, Black-tailed Godwit, Northern Lapwing, Glossy Ibis, and Black-winged Stilt. Wood Sandpipers, Little Stints, Spotted Redshanks, Eurasian Spoonbills, and Pied Avocets were much less common than expected, based on a 1988 study of the same areas. Waterbirds such as Pygmy Cormorant, Great Crested Grebe, and Slender-billed Gull were rare, as was their open-water habitat. Increased agricultural water usage in surrounding watersheds, causing lower water levels in wetlands, appears to be the main process causing waterbird declines. Species migrating through in May and those requiring open, unvegetated pools and mudflats for foraging were hardest hit, while those migrating in March or April and those capable of using marsh habitats or wet meadows were less affected. Local, regional, and national agencies and groups will need to employ more

efficient water usage, and some former drainage schemes may need to be reversed, to restore wetland habitats to their prior health.

MERCURY CONCENTRATIONS IN WADING BIRDS IN RELATION TO TROPHIC POSITION [Poster]
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Variation of mercury concentrations has been previously linked to trophic levels (greater Hg with higher trophic position) in many organisms. We tested this prediction with nestlings of 4–5 wading bird species of varying trophic level in both coastal and inland colonies. We confirmed trophic position of individual species by stable nitrogen-isotope analyses. Generally, the expected relationship between mercury and trophic position was observed for inland wading birds. However, the same was not true for all coastal wading species. Since prey type (fresh- vs. saltwater) can influence mercury bioavailability to coastal wading birds, we also analyzed for carbon isotopes. Species utilizing saltwater prey were lowest in mercury but among the highest in trophic position. Species utilizing fresh- or a combination of fresh- and saltwater foraging habitats tended to have mercury concentrations more related to trophic position. For coastal wading birds, use of different foraging habitat types (salt- vs. freshwater) confounds the relationship of trophic position with mercury accumulation.

TRACKING LARGE-SCALE MOVEMENTS OF WOOD STORKS FROM WESTERN GULF COAST STATES BY SATELLITE TELEMETRY [Poster]

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Wood Storks (*Mycteria americana*) observed in western Gulf Coast states in late summer months are generally assumed to originate from the Mexican population. However, band sightings indicate that juvenile storks from the southeastern US population disperse to the west, into eastern Mississippi. This US breeding population is federally listed as endangered, but the protection extends only to western Alabama. As a preliminary look at possible origins of Wood Storks in Gulf Coast states, we deployed 10 satellite transmitters on Wood Storks captured at three locations in 2003 to examine their large-scale movements over time. Three storks captured in eastern Mississippi (MS) eventually flew to Florida. Three storks from western MS flew to México/Guatemala. Of two storks from southern Louisiana (LA), one flew to Florida and another to México. Our findings suggest Wood Storks observed in eastern MS are from the US population, whereas most others (western MS and LA) are from the Mexican population. However, population (US and Mexican) mixing is occurring at some level.

TRENDS IN HABITAT AREAS AND POPULATIONS OF MARBLED MURRELETS IN BRITISH COLUMBIA

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The Marbled Murrelet population in British Columbia is crudely estimated to be 55,000–78,000 birds. There are insufficient data to determine the extent of population changes in BC, but anecdotal evidence and sparse data indicate declines. At-sea counts indicate declines (west Vancouver Island, southern mainland) or no trend (Haida Gwaii/Queen Charlotte Islands), but are too variable and affected by local ocean conditions to be reliable. There is strong evidence for significant loss of nesting habitat in old forests in BC, and, since radar studies show correlations between habitat area and number of murrelets, populations are presumed to have declined too. Baseline thematic mapping by Ministry of Forests estimated the original available habitat at 7.67 million ha, of which approximately 49% was logged by 2000, with 59% loss projected by 2030. More refined, but coarse-scale, modeling by Demarchi and Button (2001) suggested a 35% decline in the most likely nesting habitat by 2001, with the greatest loss on Vancouver Island and the southern mainland. Modeling by Rachel Holt (2004) indicates a 42% habitat loss by 2000 on Haida Gwaii. Radar count data have high power to detect

local population trends with relatively modest effort. Radar counts are insufficient to show current trends but are suggested for future monitoring and management of murrelets in BC.

CONSERVATION ISSUES OF THE XANTUS'S MURRELET IN CALIFORNIA

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On 16 April 2002, the California Fish and Game Commission (Commission) received a petition to list the Xantus's Murrelet (*Synthliboramphus hypoleucus*) as a threatened species under the California Endangered Species Act (CESA); the Pacific Seabird Group (PSG) submitted the petition. In response to the petition, the Department of Fish and Game (Department) produced a status report on the murrelet in November 2003, and the Commission subsequently approved state-listing of the species. The Department recommended listing of the murrelet as threatened due to: (1) small breeding population size in California; (2) documented population decline of approximately 30% from 1977 to 1991 on Santa Barbara Island; (3) declining occupancy rates at nesting sites on Santa Barbara Island; (4) near extirpation from previously known nesting sites, based on historic and current scientific information; (5) vulnerability to oil spills during the breeding and non-breeding season; (6) suppression of population growth by a variety of native and non-native predators; and (7) impacts from artificial light pollution and human disturbance activities. Monitoring programs need to be evaluated, and predation impacts need further study. The status review recommended interagency coordination with the goal of stopping, and then reversing, the population decline of the murrelet. An interagency team, including PSG, should be developed to prioritize management recommendations and assure conservation of the murrelet.

DISTRIBUTION, ABUNDANCE AND REPRODUCTION OF SEABIRDS AT GORGONA ISLAND, COLOMBIA

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Throughout 2003, we carried out visual censuses of peleciform birds at Gorgona Island National Natural Park, Colombia. We mapped the spatial distribution, estimated population densities, and recorded the reproduction of *Pelecanus occidentalis*, *Sula nebouxii*, *Sula leucogaster*, and *Fregata magnificens*. We estimated a total of 20,000 seabirds on the island. The most abundant species was *S. nebouxii*, with almost 13,000 birds, and the least abundant was *S. leucogaster*, with 300. Between February and August, we observed the simultaneous breeding of 800–1,000 pairs of *P. occidentalis*. Around 100 pairs of *S. leucogaster* bred during the year, with a concentration of the reproductive effort between July and September. We did not record breeding of *S. nebouxii* or *F. magnificens*, although we observed some courtship behavior of the latter. Explanation of the temporal variation of the populations of seabirds requires more detailed information about diet and distribution and availability of food during the year. This work marks the beginning of a standardized, long-term monitoring program of seabird populations in Colombia.

IS CLIMATE CHANGE ALTERING THE BREEDING PHENOLOGY OF THE ENDANGERED GREAT LAKES PIPING PLOVER POPULATION?

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The current global warming paradigm predicts new impacts on ecosystems and the organisms that inhabit them. In the Great Lakes region, climate change will likely alter temperature trends, seasonality, and water levels. The Great Lakes Piping Plover population breeds in shoreline habitat that is sensitive to climate-induced events. The purpose of this study was to analyze a 10-year database on breeding phenology to determine if plovers are responding to regional climate fluctuations. The Piping Plover appears to be nesting earlier, with year alone as a statistically significant indicator. We also examined correlations between May daily low temperatures and nest-initiation dates. It appears that earlier mean nest initiation correlates with fewer days in May with temperatures falling below 45°F. Also examined were correlations between precipitation and reproductive success and correlations between lake levels and reproductive success. These correlations are less clear but may become more important with future changes in amount of lake level fluctuation, overall water-

level changes, and changes in weather patterns. By predicting reasonable scenarios of the effects of global climate change on the Great Lakes population of the Piping Plover and its habitat, we can make informed management decisions.

NESTING ACTIVITIES OF HERONS DURING A CULL OF 6,030 CORMORANTS ON LAKE ONTARIO, 2004 [Poster]

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On 13 days from 6 May–7 June 2004, 6,030 tree-nesting Double-crested Cormorants (DCCOs) were shot (with .22 rifles) on their nests at High Bluff Island at Presqu'Île Provincial Park on Lake Ontario. The purpose of the cull was to remove nesting cormorants from the tree and shrub vegetation to preserve them for nesting herons and esthetics. Nesting activities of Great Blue Herons (GBHE) and Great Egrets (GREG), which nested among many of the cormorants, were monitored frequently from afar. GBHEs built 69 nests; 31 were taken over by DCCOs, and the remaining 38 nests produced 75 young (1.97 yg/nest). GREGs built 29 nests, but no more than 10 were active at any one time. Eight nests were taken over by DCCOs, 7 were abandoned, 4 simply disappeared, and 10 were successful. The 10 nests produced 26 yg (2.6 yg/nest). GBHEs often successfully thwarted cormorant attempts to usurp their nests. GREGs in canopy nests often vacated their nests after short bouts of bill-thrusting with usurping cormorants; GREGs in low-level shrubby vegetation nests fared much better. Black-crowned Night-Herons (BCNHs) nested in cherry shrubs and a willow; many of the latter nests were also taken over by DCCOs. Culling activity appeared to have had minimal impact on the heron species that nested with the cormorants.

SETTLEMENT PATTERN IN A COMMON TERN COLONY: THE ROLE OF HABITAT QUALITY AND CONSPECIFIC ATTRACTION [Poster]

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Nest-site selection is a characteristic under potentially high selective pressure; it also determines spatial distribution of individuals in heterogeneous landscapes. Individuals seem to base nest-site choice on two main sets of information: intrinsic features of the habitat and conspecific-based cues. Nevertheless, it is poorly understood how these types of information interact in determining spatial distribution of nests. Here, we analyze data from nest locations of a colony of Common Terns scattered over small islands in a marshland area in the Ebro Delta (NE Spain). Previous studies in that colony have shown that height above water level is an important feature that determines the risk of flooding. Additionally, terns seem to settle preferentially close to conspecifics. During the 2000 breeding season, this colony was surveyed every two days to record laying date of first egg. At the end of the breeding season, nest position was accurately determined using topographical surveys. We apply spatial models for point-process analysis to elucidate nest density dependence in relation to height and to date of nest settlement.

AT-SEA SURVEYS OF MARBLED MURRELETS: METHODOLOGICAL CONSIDERATIONS [Poster]

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Marbled Murrelets (*Brachyramphus marmoratus*) are solitary nesters that nest in the tops of old-growth trees. As a result, surveys are necessarily conducted on populations at sea. We evaluated the accuracy of alternative line transect methods and described the spatial distribution and density of Marbled Murrelets in Stephen's Passage, Southeast Alaska. We used these results to develop an optimal survey design. We found that the perpendicular distance from the object to the transect centerline could be calculated more accurately by estimating radial distance and angle than by estimating the perpendicular distance directly. Repeated boat surveys along 23 transects (range 5.4–12 km) were conducted in the study area using GPS to record all bird locations spatially. The information gathered from the survey produced density estimates of 41.3 murrelets/km² (95% CI = 25.73–50.268) for June and 47.1 murrelets/km² (95% CI = 30.546–55.707) for July. Half of all murrelets occurred within 2.0 km of the shore, and peak density occurred 1.7 km from shore. Bird density

varies greatly with distance from shore; therefore, the optimal survey design would orient transects perpendicular to shore and calculate density from line transects using radial distance estimates and measured angles.

LINKING BREEDING AND WINTERING DIETS OF SYMPATRIC COMMON AND ARCTIC TERNS USING STABLE-NITROGEN AND STABLE-CARBON ISOTOPES

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Our understanding of the biology and population dynamics in long distance migrant seabirds is restricted by our lack of understanding about their biology off the breeding grounds. Common Terns (*Sterna hirundo*) and Arctic Terns (*Sterna paradisaea*) are closely-related seabirds with similar life-histories and overlapping breeding ranges, but different migration routes and wintering grounds. We wanted to determine how terns alter their diets between the breeding and wintering grounds. Stable isotopes of Carbon [$^{13}\text{C}/^{12}\text{C}$] and Nitrogen [$^{15}\text{N}/^{14}\text{N}$] allowed us to compare diet on the wintering grounds inferred from breast feathers, grown in winter, with albumen and yolk from eggs produced on the breeding grounds. We found a significant difference between Common and Arctic Tern diets on the wintering grounds; we also found no difference between the same species from two breeding colonies. Arctic Tern values indicate that they are feeding on Antarctic krill. Common Tern values suggest that they are feeding on marine fish. Both tern species changed their diets during egg production on the breeding grounds. On the breeding grounds, we found no difference between Common and Arctic Tern diets; feeding on a mix of shrimp and marine fish. There was a difference in both species diets between islands. We provide further evidence that Common and Arctic Terns use exogenous reserves for egg production.

A NOTE OF CAUTION WHEN USING ANIMAL TISSUE PRESERVED IN QUEEN'S LYSIS BUFFER FOR CARBON AND NITROGEN STABLE-ISOTOPE ANALYSIS [Poster]

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We analyzed the blood of 2 species of terns at different concentrations of blood to the preservative Queen's lysis buffer (QLB) for stable-nitrogen ($\delta^{15}\text{N}$) and -carbon ($\delta^{13}\text{C}$) isotope analysis. We compared these values to QLB and 2002 untreated tern blood isotope values, to determine the effects of different concentrations on stable-isotope values of blood. The $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values for the blood/QLB mix compared to % N values (range 2.48–9.50) revealed an effect of concentration on the $\delta^{15}\text{N}$ values. QLB exhibits low stable-nitrogen values ($\delta^{15}\text{N} = 0\text{--}0.46\%$) and nitrogen content, which reduce the blood isotope values and % N of samples. This study demonstrates that blood/preservative concentrations, as well as different preservations methods, can affect stable-isotope ratios of carbon and nitrogen. The correction factor offered by Hobson et al. (1997) for QLB can be used, but researchers must use the same concentration of blood to QLB. Concentration curves for the specific tissue can be constructed if concentrations are known. For studies using archived samples, we suggest more research emphasis on effects of preservatives, particularly for those samples containing different concentrations of tissue and preservative.

ESTIMATING BYCATCH OF MARBLED MURRELETS IN CANADIAN GILLNET FISHERIES

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Marbled Murrelets are listed as Threatened in Canada, due primarily to nesting-habitat loss; however, threats from oil spills and gillnet mortality are acknowledged by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as threats. Marbled Murrelet mortality due to commercial gillnet fishing in British Columbia has received little critical examination. A study conducted in Barkley Sound during 1979 and 1980 documented 28 Marbled Murrelet deaths that resulted from gillnet fisheries. Since that time, the Department of Fisheries and Oceans (DFO) has reduced the frequency and duration of commercial salmon

gillnet openings in Barkley Sound. Furthermore, DFO has initiated a commercial-license retirement program, thereby reducing number of fishing vessels. Between 1995 and 2001, observers recorded seabird bycatch in test gillnet fisheries off the west coast of Vancouver Island. In a total of 5,425 sets, 6 Marbled Murrelets were caught in gillnets. Observers in test gillnet fisheries for Area 4 (2000) and Johnstone Strait (1997) recorded similar numbers. We seek to estimate the magnitude of the impact of gillnet fishing on Marbled Murrelet populations in BC. In 2004, Environment Canada and DFO initiated an observer program to estimate Marbled Murrelet bycatch in commercial fisheries. Using the results from 2004, we plan to modify and expand the program to obtain robust coast-wide estimates of Marbled Murrelet bycatch in 2005 and 2006.

CALL DISCRIMINATION IN MAGELLANIC PENGUINS

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Vocalizations in Magellanic Penguins (*Spheniscus magellanicus*) compose an important component of mate selection, pair bonding and agonistic interactions. The results of this experimental study suggest that Magellanic Penguins are capable of call discrimination. Magellanic Penguins have a limited vocal repertoire consisting mostly of display calls, pair duets, fight calls, and contact calls. Display calls are used by males primarily for mate attraction. We ranked individual responses to each playback using an ordinal scale of 0–7 based on a scale developed by Speirs & Davis (1991) for their work on Adélie Penguins, *Pygoscelis adeliae*. Response categories included head orientation toward call source, response calls, movement toward call source, etc. We found that females discriminated between the display calls of mates versus strangers and mates versus neighbors, but not between calls of strangers and neighbors. Male discrimination response to display calls was weaker, but still significant. Male response to pair duets was very strong, showing highly significant differences in response to their own duet versus a stranger pair's duet. The results of these playback experiments provide evidence of call discrimination in Magellanic Penguins.

SNOWY PLOVER REPRODUCTIVE SUCCESS IN BEACH AND RIVER HABITATS

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Poor reproductive success has contributed to the decline and low population size of the federally listed Western Snowy Plover (*Charadrius alexandrinus nivosus*), especially where it breeds on coastal beaches used by humans for recreation. From 2001–2004, reproductive success of color-marked plovers breeding on ocean beaches and gravel bars of the lower Eel River was monitored in coastal northern California, one of six recovery units as identified by the species' recovery plan. In three of four years, more plovers (54–64%) nested in river than beach habitats, but this pattern was reversed in the last year of study, when 62% of plovers used beaches. Each year, a higher proportion of clutches hatched and more chicks fledged from river than beach habitats, producing a disproportionate number of yearlings recruited into the local population from the river. On average, river-nesting males tended significantly fewer eggs, hatched similar numbers of chicks, and fledged significantly more young than did males breeding on beaches. Female patterns were similar, although only significant for fledging success. Corvids were more prevalent in river habitats in two of four years, but beaches consistently had significantly greater human activity. These habitat differences in reproductive success persist despite efforts to manage predators (e.g., exclosures around nests) and humans (e.g., signs, fencing, and vehicle restrictions) on beaches and almost no management of river habitats.

INDIVIDUAL ASSOCIATIONS IN A WINTERING DUNLIN POPULATION: DO DUNLINS HAVE FRIENDS?

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To examine the role of social dynamics in patterns of high-tide roost use, we analyzed flock size and pairwise co-occurrence of radio-tagged Dunlins (*Calidris alpina pacifica*) wintering in Humboldt Bay, California. High-tide flock size associated with marked Dunlins was very dynamic, changing on average 875% from one day to the next. Although we captured all Dunlins at the same site, pairwise co-occurrence at high tide

was low (29% on average), and only four of 30 pairs co-occurred more than expected by chance. Marked Dunlin pairs that shared a primary roost were no more likely to co-occur than pairs with different primary roosts. High-tide associations of marked Dunlins were short-lived (1.6 high tides on average), with only 44% persisting to the next high-tide. These results suggest that wintering Dunlin flock composition is fluid and opportunistic from the perspective of the individual and that persistent social groups may not exist.

DIETARY RESPONSE OF THE ELEGANT TERN (*Sterna elegans*) TO CHANGING OCEAN CONDITIONS AND PREY POPULATIONS IN SOUTHERN CALIFORNIA [Poster]

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We compared diets of the Elegant Tern at three nesting sites in southern California in 2004 to help determine whether ocean conditions have shifted from a warm to a cool regime since 1999 and, therefore, whether this abundant seabird can be used as an indicator of oceanographic regime changes. Previous studies have shown that northern anchovies are a major prey species for this tern but that, during warmer years, as in the mid-1990s, Pacific sardines can become a more important prey species than the anchovy. Specifically, if the ocean is now in a cool regime, we expected a higher anchovy to sardine ratio in this tern's diet at all three sites, but more pronounced at the two more northerly locations (Los Angeles Harbor and Bolsa Chica Ecological Reserve). We also expected the Elegant Tern to have a broader diet at the more southerly site (San Diego Salt Works) because of a greater subtropical influence. Diets were assessed by identifying fish dropped by the birds at the colonies or regurgitated by the young during parent-chick feeding encounters at the three sites. Analyses to date have focused only on material from Los Angeles Harbor and Bolsa Chica and reveal at least a 10:1 anchovy:sardine ratio, suggesting that a cool regime is in place.

OBSERVER BIAS AND ACCURACY OF FIELD IDENTIFICATION OF FORAGE FISH IN BILL-LOAD HOLDING SEABIRDS

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We investigated the bias and accuracy of individual observers with regard to their ability to identify species and estimate length of prey items held in the bills (i.e., bill-loads) of Caspian Terns (*Sterna caspia*). In recent years, the diet of Caspian Terns has been intensively studied in the Puget Sound, Columbia River watershed, and San Francisco Bay. Increasingly, Caspian Tern diet studies are reliant on direct field observations as a means of determining fish identification and length estimates. These data are then used in bioenergetic models estimating prey consumption. Current training in forage-fish identification of bill-loads is typically composed of a highly expert observer sitting by a novice until the expert is comfortable with the novice's skills. Talented experts can be more than 95% accurate for both size and species of fish, but bias and accuracy of field-based observations has been little studied. We measured relative accuracy of highly experienced observers, as well as recently trained and untrained novices, and found significant biases, both within and among groups. We have developed a training protocol and criteria for testing observer bias in bill-load identification that includes a customized field guide and digital photos for review. We have also elaborated on our protocols with the specific interest of extending the techniques utility to biologists studying bill-loads in loons, puffins, guillemots, murrelets, auklets, terns, and skimmers.

TRACKING OCEAN WANDERERS: THE GLOBAL DISTRIBUTION OF ALBATROSSES AND PETRELS

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Nineteen of the 21 species of albatrosses are now under global threat, according to IUCN Red List criteria, with the remaining two near threatened. Their extensive foraging ranges make albatrosses particularly

vulnerable to commercial longlining and trawl-fishing operations throughout the world's oceans. As a consequence, it is estimated that at least 100,000 albatrosses and large petrels are killed every year. In response to these threats to albatross populations, BirdLife International embarked on an effort to create a global Procellariiform tracking GIS database representing over 30 researchers from 9 countries with a number of strategic aims, including: (1) to develop criteria for defining marine Important Bird Areas; (2) to quantify overlap between marine areas used by seabirds and potentially detrimental fisheries; and (3) to identify Regional Fishery Management Organizations with jurisdiction over these fisheries. Key findings to date include identifying both hotspots where concentrations of longliners, trawlers, and seabirds occur and important continental-shelf areas where albatrosses and petrels forage. A full report, recently published by BirdLife International, is now available (contact Cleo.Small@rspb.org.uk).

SWALLOWS: AN AQUATIC INDICATOR SPECIES OF CONTAMINANT EXPOSURE AND EFFECTS

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Swallows, especially Tree Swallows (*Tachycineta bicolor*), are being used across North America to quantify exposure and effects of environmental contaminants. Swallows are an especially useful indicator species because they breed from Alaska to Florida, they will readily use nest boxes so they can be attracted to areas of concern, they will nest in high densities, and they are associated with a variety of aquatic habitats, including rivers, lakes, and other palustrine wetlands, where contaminants frequently accumulate. They are obligate insectivores, and their diet of primarily emergent aquatic insects link, in just two short steps, sediment contamination through benthic invertebrates to bird tissues. Effect levels of polychlorinated biphenyls and dioxins have been established for hatching success. Physiological and genetic responses to environmental contaminants have also been established. Case studies will be presented for swallow studies in Colorado, Massachusetts, and Rhode Island.

REPRODUCTIVE FORAGING OF FIVE SYMPATRIC ALCIDS

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We used stable-isotope methods to describe foraging behaviour during reproduction for five sympatrically breeding Alcids: Cassin's Auklet (*Ptychoramphus aleuticus*), Rhinoceros Puffin (*Cerorhinca monocerata*), Tufted Puffin (*Fratercula cirrhata*), Common Murre (*Uria aalge*), and Pigeon Guillemot (*Cepphus columba*), at Triangle Island, BC, Canada. For each species, we collected fifteen blood samples from: (1) pre-laying, (2) incubating, and (3) provisioning adults, and from (4) nestlings. These blood samples were analyzed for $\delta^{15}\text{N}$ (trophic level of prey eaten) and $\delta^{13}\text{C}$ (location of prey capture). Prey delivered to nestlings (zooplankton and fish) were collected as isotopic references and used, with nestling blood values to calculate field-based estimates of $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ fractionation factors. Results indicate that some species (especially Tufted Puffin) show marked within-season shifts in diet and foraging habitat, while others (especially Pigeon Guillemot) do not. At the community level, there was a marked shift from use of both zooplankton and fish early in the season to feeding exclusively on fish later in the season. While piscivory was generally associated with nearshore habitats, the seasonal shift from a mixed diet to exclusive piscivory was not accompanied by a seasonal shift from offshore to inshore. Based on seasonal spikes in availability of zooplankton and fish, we conclude that these alcids time their breeding so that they are raising nestlings when the most appropriate food is available.

QUANTITATIVE AND DESCRIPTIVE ANALYSIS OF THE VOCAL REPERTOIRE OF XANTUS'S MURRELET (*Synthliboramphus hypoleuca*) AND ITS POTENTIAL FOR VOCAL INDIVIDUALITY [Poster]

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From recordings made during the breeding season, Xantus's Murrelets (*Synthliboramphus hypoleuca*) have at least four adult call types (*Twitter*, *Chips*, *Peers* and *Whistles*). Chicks have at least two vocalizations (*Chick*

Twitter and *Chick Peers*), plus one non-vocal sound (*Bill-clapping*). Most vocal activity is nocturnal and confined to staging areas near the colonies. Chicks are raised for 2–3 days in the burrow, fledge, and then must reunite with their parents at sea for continued care. Vocal recognition probably drives this reunification and has been found in related alcids. If individual vocal stereotypy could be readily detected, it could be exploited to improve censusing or population-monitoring efforts. Without visual confirmation, individuals were determined circumstantially (multiple calls from fixed location). Captive recordings of two chicks were also made and their *Peer* calls assessed for individuality. Potential for vocal individuality was found in both the adult and chick calls by all methods (visual sorting of sound spectrograms/amplitude envelopes, multidimensional scaling, and cluster analyses), but methodological refinement is necessary for this to be a practical management tool. *Chick Peer* calls unexpectedly showed dual voicing (resonance of sound from two parts of the syrinx), a first for the Alcidae, which might be important for recognition.

THERE IS A SEASON, TERN, TERN, TERN: ARCTIC TERN POPULATION VIABILITY IN THE GULF OF MAINE

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While no population viability model can predict the future accurately, each model can help managers focus research efforts and management techniques. Arctic Terns in the Gulf of Maine are part of a structured regional population, with nesting colonies concentrated on a few managed islands. In 1999, we initiated a banding and resighting study to examine this species. We have used capture-mark-recapture analysis of banded individuals to develop and examine the first estimates of survival and movement of Arctic Terns banded as chicks and as adults in North America. Using these data and estimates of fecundity, we examined the viability of the population. Our analysis indicates that, if current trends in productivity, survival, and movement continue, the population may experience fluctuations but will remain relatively steady within the region. However, Peregrine Falcons have increased in number within the region and in the frequency of visits to some colonies and may play an increasingly important role in the survival of the terns. There has also been wide variation in the diet of the nesting terns. These factors, in terms of increased predation on terns and potential food limitations, could play a larger role than before in the future of this species within the region.

THE DEMOGRAPHIC RESPONSE OF BLACK GUILLEMOTS TO A SHIFT IN THE ARCTIC OSCILLATION

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The Black Guillemot is a high-arctic seabird that relies heavily on the sympagic food web associated with pack ice. In the western Arctic, a shift from a cold to a warm phase of the Arctic Oscillation (AO) in 1989 resulted in major decreases in the pack-ice habitat that provides Black Guillemots its primary prey of arctic cod. A guillemot colony in northern Alaska, studied annually since 1975, has shown the impacts of this shift in a number of demographic parameters. The breeding population decreased from just over 200 pairs in the late 1980s to 120 pairs in 1997. Breeding success averaged >50% before 1989 but since has decreased to <25%, with breeding success averaging 14% in this century. Adult survival averaged 92% in the 10 years before the AO shift but declined to 84% in the 7 years after. Climate models suggest that increased greenhouse gases may be forcing the AO to remain in a warm mode. A return to a cold phase, as existed before 1989, is unlikely to occur soon. The colony is currently maintained by immigration from less affected regions and will persist only as long as breeding productivity in those areas remains high.

STABLE ISOTOPES IN WESTERN ARCTIC BLACK GUILLEMOT FEATHERS, 1875–2002: LONG-TERM TROPHIC LEVEL STABILITY VS. RECENT DECADEAL CHANGES IN PRIMARY PRODUCTION
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Stable nitrogen isotopes in Black Guillemot feathers collected from 1875 to 2002 revealed no significant seasonal or annual variation, with $\delta^{15}\text{N}$ averaging 19.07‰. Based on contemporary $\delta^{15}\text{N}$ values of prey species, guillemots are feeding at a trophic position of 4.4, indicating a long-term and almost complete dependence on arctic cod, the primary fish species in the sympagic foodweb associated with pack ice. The continued reliance on arctic cod is surprising, given the major documented changes in extent and volume of regional pack ice in the last half of the Twentieth Century. Contrasting with the lack of temporal variation in $\delta^{15}\text{N}$, $\delta^{13}\text{C}$ declined approximately 1.8‰ from the 1950s to the end of the century. While a similar decrease in $\delta^{13}\text{C}$ in other species has been attributed to a regional decrease in primary productivity, the decline could also be due to (1) anthropogenic changes in atmospheric CO_2 from the burning of fossil fuels or (2) the relative contribution of ice-associated diatoms vs. open water plankton. Feathers from historic and contemporary seabird specimens allow examination of temporal variation in trophic dependencies using $\delta^{15}\text{N}$. However, recent changes in atmospheric carbon confound the discrimination of global vs. local forcing factors, limiting the reliability of interpretations of $\delta^{13}\text{C}$ variation.

POPULATION STRUCTURE AND GENETIC DIVERSITY IN LEAST TERNS

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Least Terns (*Sterna antillarum*) have undergone large population declines due to direct and indirect anthropogenic pressures on their breeding and foraging habitat. Three subspecies of Least Terns have been described within the United States: California Least Tern (*S. a. browni*), Interior Least Tern (*S. a. athalassos*), and Eastern Least Tern (*S. a. antillarum*). California and Interior subspecies are listed as endangered under the U.S. Endangered Species Act. However, the taxonomic status of Least Terns is a highly contentious issue that has implications for setting conservation priorities at erroneous levels of taxonomic distinctness. Understanding population structure and taxonomy is critical for successful conservation of Least Terns. We sampled 7 breeding populations of Least Terns representing all three subspecies. To clarify the relationships among populations and define appropriate conservation units, we used 9 variable microsatellite loci to examine the genetic structure of the three subspecies. Mean overall heterozygosity across all samples and loci was 0.695, with allele numbers ranging from 2–19 alleles per locus. The global FST, a measure of population subdivision, was not significant (0.039, $P > 0.5$). However, pairwise FST comparisons between subspecies show highly significant structure ($P < 0.003$). Analysis of molecular variance (AMOVA) found that most of the variation was among individuals within populations (95%).

THE ASIAN WATERBIRD CENSUS: A TOOL FOR WATERBIRD AND WETLAND CONSERVATION

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In the Asia–Pacific region, more than 400 waterbird species face threats from loss and degradation of wetlands, pollution, and over-harvesting. Baseline information is crucial for effective planning and monitoring of conservation actions for waterbirds and their habitats. The Asian Waterbird Census (AWC), begun in 1987, is a regional program that collects, collates, and disseminates data on the distribution and status of waterbirds and wetlands in the region. The AWC aims to build an information base on waterbirds and wetlands through an annual January census conducted by national networks of dedicated volunteers. The AWC covers the region of Asia from Afghanistan to Japan, Southeast Asia, and Australasia. It runs parallel to other international censuses of waterbirds in Africa, Europe, West Asia, and the Neotropics under the umbrella of the International Waterbird Census and is coordinated by Wetlands International. To date, over 5700 wetlands within 26 countries have been counted at least once. Information from the AWC contributes to the identification and monitoring of wetlands of international and national importance and assists decision-makers in designating

wetlands to the Ramsar Convention on Wetlands, protecting threatened species, and assessing wetland values. The data feed into an international program to maintain an overview of the population size, status, and trends of waterbirds throughout the world. See <http://www.wetlands.org/IWC/awc/awcmain.html> for more information.

THE ASIA–PACIFIC MIGRATORY WATERBIRD CONSERVATION STRATEGY: PAST SUCCESSES AND FUTURE DIRECTIONS [Poster]

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The Asia–Pacific region is home to three migratory waterbird flyways encompassing at least 243 waterbird species, including 49 threatened species. The region also contains over half of the world's human population and the highest economic growth rates in the world, creating enormous pressures on wetlands and other natural habitats. The Asia–Pacific Migratory Waterbird Conservation Strategy, begun in 1996, is a regional initiative to enhance the long-term conservation of migratory waterbirds and their wetland habitats through (1) establishment of networks of internationally-important waterbird sites, (2) capacity-building, (3) coordinated research activities and increased information exchange, and (4) education and training. To date, three Action Plans for cranes, anatids, and shorebirds serve as the main tool in promoting conservation activities in the region. A network of 82 internationally-important waterbird sites in 13 countries provide a framework for site-based management, education, and training activities. The current strategy concludes in 2005, and discussions now are focused on ways to improve implementation of the Action Plans, increase coordination and information exchange, expand site networks, and secure the funding base. Options on the shape of the 2006–2010 Strategy include implementation of a stronger partnership framework linked to a WSSD Type-II initiative to conserve migratory waterbirds in the East Asia–Australasian Flyway. See <http://www.wetlands.org/IWC/awc/waterbirdstrategy> for more information.

MODELING ALTERNATE WETLAND MANAGEMENT SCENARIOS TO PROVIDE HABITAT FOR NON-BREEDING WATERFOWL IN THE FACE OF WATER SUPPLY SHORTAGES IN THE WESTERN UNITED STATES

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In the western United States, water supply problems are constraining how wetlands can be managed for waterbirds on publicly owned lands. Using the Lower Klamath Basin National Wildlife Refuge as a case study, we outline a process to develop wetland habitat goals and evaluate wetland management options to maximize refuge carrying capacity in the face of growing water supply uncertainty. We set population objectives, estimated food availability in permanent and seasonal wetlands, and determined the metabolizable energy of key seed species in the system. We incorporated these data, along with data on food availability in agricultural fields and migration chronology through the basin, into a stochastic, energetics-based model. Finally, we modeled several scenarios to reflect variability in the timing and amount of water available to the refuge. Results indicate that, given a quantity of water, management for early successional seasonal wetlands maximizes energy availability to waterbirds. Restricting water availability can reduce refuge carrying capacity during fall but can improve seed availability in spring, when many birds are storing endogenous energy reserves for migration and breeding.

IS EXTRA-PAIR COPULATION A MATING STRATEGY OR A BY-PRODUCT OF SEXUAL ACTIVITY IN SCARLET IBIS?

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We examined pair associations of Scarlet Ibises (*Eudocimus ruber*) housed at the Bronx Zoo during four breeding seasons (1992–1995), using continuous focal nest observations. All observed copulations were

recorded and categorized as either pair copulations or extra-pair copulations. In general, copulatory behavior was low, with only 362 pair copulations and 175 extra-pair copulations occurring during 800 hours of colony observation. Pair copulations increased dramatically from mid-May through mid-June, declined with the onset of incubation, and increased again slightly in July. The number of extra-pair copulations was highest during the egg laying and incubation stages of reproduction. Both types of copulations decreased gradually throughout the rest of the breeding season, stopping completely by early November. Even though extra-pair copulations and copulation attempts occurred, no offspring resulted from these copulations, as evidenced by DNA profiles.

FLIGHT SPEEDS OF TWO SEABIRDS: A TEST OF NORBERG'S HYPOTHESIS [Poster]

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Norberg (1981) suggested that birds should increase their flight speed when rearing chicks to maximize the chick energy intake by reducing commute time. We measured flight speeds of medium-range (Thick-billed Murre) and long-range (Northern Fulmar) foragers during incubation and chick-rearing near the Prince Leopold Island, NU. The mean flight speed for the long range forager was significantly higher during chick-rearing than during incubation. The medium-range forager did not show any difference in mean flight speed between the two periods. We suggest that, because petrels fly close to their minimal power velocity and have a low wing-loading while alcids fly close to their maximal range velocity and have a high wing-loading, petrels have a greater ability than alcids to alter their flight speed according to changing optimal currencies. Consequently, whereas Northern Fulmars adapt to the additional cost of chick-rearing partially by altering flight speed, Thick-billed Murres can do so only by reducing mass.

VALUE OF RESERVOIRS AS SHOREBIRD MIGRATION HABITAT [Poster]

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As one of the few wetland types that continue to increase in the US, reservoir habitat may help offset the loss of natural wetlands for migrating shorebirds; however, little is known about the quality of reservoirs as habitat for shorebirds. We examined shorebird use and food resources at a large inland reservoir in southern Illinois during fall migration in 2000 and 2001. We counted 3,780 shorebirds representing 23 species and 6,382 shorebirds representing 21 species during fall migration of 2000 and 2001, respectively. Benthic invertebrate resources were comparable to those at other shorebird stopover sites (median density = 26,096 invertebrates/m²; median biomass = 2.40 g dry mass/m²), suggesting that reservoirs are capable of providing high-quality habitat. The value of reservoirs may be particularly high during drought. We recommend that, when feasible, reservoir construction and management consider and promote shorebird use.

INFLUENCE OF MUDFLAT WIDTH ON SHOREBIRD FORAGING BEHAVIOR AT AN INLAND RESERVOIR

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During fall migration of 2000 and 2001, we examined time-activity patterns for shorebirds on a large Illinois reservoir and tested how mudflat width and flock size affected time spent foraging and alert using an information-theoretic analytical approach. We predicted that shorebirds would spend more time alert and less time feeding when foraging on narrow mudflats and that this relationship would be more pronounced for shorebirds in small flocks. Shorebirds spent the majority of time feeding (78.4% ± 2.5), followed by alert behavior (10.9% ± 2.0). The full model, including distance to cover, flock size, and its interaction, was selected as the best model explaining time spent alert by Pectoral Sandpipers and small sandpipers. Time spent alert was inversely related to mudflat width, and this relationship became particularly strong as flock size decreased. The full model also best explained small-sandpiper feeding time, with reduced feeding observed on narrow mudflats, particularly when foraging in small flocks. Additionally, shorebird abundance was higher on wide mudflats. Results suggest a positive association between mudflat width and habitat quality, thus providing guidance on construction and management of migration habitat for shorebirds.

POTENTIAL USE OF LIDAR DATA IN SHOREBIRD HABITAT ANALYSIS USING SNOWY PLOVERS AS A CASE STUDY [Poster]

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Assessing habitat suitability using GIS data sources is useful because habitat features can be measured from GIS layers across the landscape. A variety of information such as vegetation type and distance to cover can be obtained from land cover data. However, slope, water depth, and inundation patterns are critical factors affecting shorebird habitat, and these factors are difficult to evaluate or measure from most remotely sensed data. Fine-scale topographic information obtained from Airborne Topographic Mapper Airborne Light Detection and Ranging (LIDAR) data can be used to model gently sloping shorelines and can assist in evaluation and quantification of shorebird habitat. We obtained LIDAR data for the Oregon coast to measure and evaluate habitat characteristics at Snowy Plover nests. Digital Elevation Models (DEMs) were generated from LIDAR and used to measure slope, aspect, and the distance from nest locations to Mean Higher High Water (MHHW). Average slope at the nest and along the beach was 6.0%, average distance to MHHW was 99.5 m, and aspect was highly variable. Since LIDAR data are readily available for most US coastal areas, they potentially can be used range-wide to identify suitable habitat for Snowy Plovers and many other shorebird species.

NUTRIENT TRANSFER FROM SEA TO LAND: GULLS AND CORMORANTS IN COASTAL NEW ENGLAND

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Seabirds are capable of introducing large amounts of marine-derived nutrients to land, thereby altering resource availability to terrestrial species. Little is known about how species-specific characteristics of seabirds alter their effects on terrestrial communities. We compared the effects of Great Black-backed Gulls (*Larus marinus*) and Double-crested Cormorants (*Phalacrocorax auritus*) on soil nutrients and plant species composition on offshore islands in Maine, USA. Soil ammonia concentrations were higher in the active cormorant colony than in all other colonies; phosphate was highest in an abandoned cormorant colony. Ammonia and phosphate concentrations were good predictors of plant species composition; more annual forbs than perennial grasses occurred in the abandoned cormorant colony than in the gull colonies. Most plants showed enriched $\delta^{15}\text{N}$ signatures. The 3 plant species that occurred in both the abandoned cormorant and gull colonies showed greater $\delta^{15}\text{N}$ enrichment in the cormorant colony. Germination rates of a phytometer (*Brassica rapa*) were lowest in soils from the cormorant colonies. High concentrations of soil nutrients in cormorant colonies were a form of severe disturbance that negatively affected plants. Species-specific variation in resource transport should be considered when predicting the effects of seabirds on terrestrial habitats.

GULL-BILLED TERNS IN NORTH AMERICA: POPULATION CHANGES AND COLONY-SITE MODELS

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We conducted a status and distribution assessment of Gull-billed Terns in North America and determined that populations have declined in most of the Atlantic region but may be fairly stable in Texas and southern CA. More data are needed in México before trends can be determined. Threats include disturbance, predator expansions, and sea-level rise. In Virginia, we used a 30-yr database to model colony-site dynamics using probabilistic models. Unlike other metapopulation applications, we could assume that all occupied sites (i.e., nesting colony) would be detected with $P = 1.0$. We determined that time period (predator level) and

colony size were much more important to colony extinction rates than was habitat type (barrier island vs. small marsh/shell island). This may be the first quantification of a predator expansion altering colony site dynamics.

POPULATION GENETIC STRUCTURE IN THE ENDANGERED MARIANA COMMON MOORHEN

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The endangered Mariana Common Moorhen (*Gallinula chloropus guami*) is one of the last remaining endemic wetland-dependent birds of the Mariana archipelago. Recent estimates put the adult population at less than 300 individuals. In this study, we used mitochondrial DNA (mtDNA) to examine genetic variation within and among populations from Guam and Saipan. Over 1,500 bps of sequence data from the mtDNA control region and ND2 region were analyzed for 35 individuals from these two islands. Samples from six Hawaiian Common Moorhens (*G. c. sandvicensis*) served as an outgroup and proved to be significantly different from the Mariana subspecies. Results for the Mariana moorhens suggest a severe lack of genetic diversity and reveal little structure. Analyses identified three distinct haplotypes within these birds. Those from Guam displayed all three haplotypes; those from Saipan, just one. This study supports the view of a single conservation unit for the Mariana Common Moorhen. We acknowledge the need, however, to develop nuclear markers before any further recommendations can be made.

COMPARATIVE ANALYSIS OF GENETIC STRUCTURE IN FOUR SPECIES OF TERNS THAT BREED IN BRAZIL: IMPLICATIONS FOR CONSERVATION

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There are no data available about movements, philopatry, and genetic structure of many species of seabirds that breed along the coast of Brazil. This study contributes information on genetics and evolution of terns in Brazil through a comparative analysis of phylogeography, population structure, and genetic variability using different molecular markers (mitochondrial and nuclear DNA). Three hundred and sixty-six individuals from four species of the family Sternidae (*Sterna hirundinacea*, *S. fuscata*, *S. maxima* and *Anous stolidus*) were analysed. Partial sequences of mtDNA genes (ND2 and ATPase6/8) and microsatellite loci previously described for other species were obtained from different areas in Brazil. The number of polymorphic loci ranged from 2 in *A. stolidus* to 7 in *S. fuscata*. No significant structure was obtained among individuals from all four species along the coast of Brazil using both molecular markers. These results indicate that each species of tern from the Brazilian coast constitutes a unique interbreeding population and requires a specific conservation plan in the breeding areas and throughout their distribution.

EFFECT OF ECTOPARASITES ON CORTICOSTERONE LEVELS OF BROWN PELICAN NESTLINGS [Poster]

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The population of Brown Pelicans (*Pelecanus occidentalis carolinensis*) in South Carolina appears to be declining. In an effort to determine potential factors underlying this trend, we investigated the impact of soft ticks (*Ornithodoros* spp.) on nestling growth and survival. Specifically, we measured baseline plasma corticosterone levels of nest-bound chicks on Marsh Island in Bull's Bay, South Carolina. We hypothesized that levels of corticosterone would be positively correlated with tick load and that chicks in nests treated with insecticide would have lower levels of corticosterone than chicks from untreated nests. We established six experimental plots throughout the colony, each with four untreated nests and four nests treated with insecticide. From these, we selected 24 study nests (13 treated, 11 untreated) and collected blood samples from the largest

chick in each brood as soon as it was captured. We found no correlation between corticosterone levels and degree of tick infestation and no significant relationship between corticosterone levels and nest treatment. These results suggest that the physiological stress level of alpha pelican chicks does not respond strongly to the degrees of tick infestation observed in this study. We will examine corticosterone response in all hatch orders in 2005.

VARIATION IN THE WING MORPHOLOGY OF WESTERN SANDPIPERS

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Wing size and shape variation in sex and age classes of Western Sandpipers (*Calidris mauri*), a species with differential migration by sex and age, were examined using size-constrained components analysis. Wing morphology of females was studied throughout the annual cycle, and data for males were obtained during the non-breeding season in northwest México. Wing morphology differed by sex and age during the non-breeding season. Adults had longer and more pointed wings than juveniles and, within each age-class, females had longer and more pointed wings than males. Wing morphology of females did not appear to differ during their annual cycle. Throughout the annual cycle, adult females tended to have longer, more pointed wings than juveniles. This study indicates that there are intraspecific differences in wing morphology in the Western Sandpiper. Differences in wing morphology can be related to migration distance, acrobatic aerial displays, and susceptibility to predation. The interplay among different conflicting pressures on wing morphology in species with age-sex differential migration merits further study. Sex and age should be taken into account to determine better their relative importance in determining the wing morphology of species with differential migration.

STABLE ISOTOPES, MERCURY, AND SELENIUM AS ECOLOGICAL BIOMARKERS: EGRETS FROM BIRAMAS (CUBA)

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Hérons and egrets have been extensively used as bio-indicators of wetland ecosystems' health. This usually implies inter-specific within locality comparisons or intra-specific between locality ones. In most cases, these comparisons render highly heterogeneous results that are difficult to interpret. At Biramas wetlands (Cuba), we took samples of contour feathers of chicks of three egret species (*Egretta tricolor*, *E. thula*, and *Bubulcus ibis*) to analyse concentrations of Hg, Se, and Pb, along with signatures of C and N stable isotopes. Our results indicate that, while the trophic level exploited by egrets was rather homogeneous, the compartments of the ecosystem in which they foraged were different. So, the levels of trace pollutants shown by each species are representative of different wetland habitats. Such differences are also well described by Hg, discriminating between terrestrial and aquatic foraging habitats (i.e., *Bubulcus* vs. *Egretta* species) and Se, which discriminates quite well between the two *Egretta* within the aquatic environment, owing to differential bioavailability of Se for prey of both species. We conclude that, after controlling for sources of variation like bioaccumulation and biomagnification (diet), the pollutant load values might be straightforwardly interpreted.

AVAILABILITY AND WINTER DEPLETION OF SUBMERGED AQUATIC VEGETATION ON LOWER KLAMATH AND TULE LAKE NATIONAL WILDLIFE REFUGES [Poster]

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In permanently flooded wetlands, submerged aquatic vegetation (SAV), such as sago pondweed and coontail, is frequently an important item in the diet of many waterbirds in fall and winter. However, little is known regarding pre-winter biomass and over-winter depletion of SAV, making it difficult to estimate the carrying capacity of permanent wetlands during fall and winter for waterbirds. We estimated pre- and post-winter SAV production and over-winter depletion on three permanent wetland units on Lower Klamath and Tule

Lake National Wildlife Refuges during 2002–2003. Pre-winter sampling occurred during early October; post-winter sampling occurred during early March. SAV biomass ranged from 294 to 620 kg/ha. Over-winter depletion of roots and tubers ranged from 0 to 66% and was positively correlated with pre-winter biomass. We used energetic modeling with estimates of metabolizable energy of SAV to estimate carrying capacity of this habitat for waterfowl.

BEACHED-BIRD SURVEYS WITHIN THE WADDEN SEA TRILATERAL MONITORING AND ASSESSMENT PROGRAM (TMAP)

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Beached-bird surveys have been carried out on southern North Sea coasts since the 1970s in The Netherlands and since the mid 1980s in Germany and Denmark. The TMAP, which was established in 1994, is carried out in the framework of the Trilateral Cooperation on the Protection of the Wadden Sea, which includes Denmark, Germany, and The Netherlands. Its objective is an integrated monitoring and assessment of the Wadden Sea ecosystem. Beached-bird surveys use trilateral standardized procedures and are assessed and evaluated as part of the TMAP. The results are published at regular intervals in Wadden Sea Quality Status Reports by the CWSS. The results of the surveys within the Wadden Sea and adjoining regions show steady declines in pollution levels since the mid 1980s. Oil rates—the proportion of beached birds that are oiled—of especially pelagic and offshore species are, however, still high on southern North Sea coasts. An Ecological Quality Objective (EcoQO) “proportion of oiled Common Guillemots *Uria aalge* among those found dead or dying on beaches” is being developed within the OSPAR Convention on the Protection of the Marine Environment of the North East Atlantic. Present oil rates for this species in the southern North Sea are still much higher than the proposed 10% of the EcQO.

USING LONG-TERM BEACH MONITORING DATA IN OIL-SPILL DAMAGE ASSESSMENTS

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An important rationale for beached-bird monitoring programs is that they provide data that are useful in assessing oil-spill damages to seabirds. The primary use of these data so far has been to help measure the extent to which normal or ambient deposition is elevated by an oil-spill incident. Ideally, these monitoring data can be used to establish a baseline of natural carcass deposition. The rate of baseline deposition is subtracted from the deposition rate observed during a spill response, and the difference is assumed to be a measure of the effect of the oil spill. But monitoring data are generally collected using protocols that result in much higher estimates of the deposition rate than protocols used during a spill response. This results from several factors, the most important of which is the interval between searches. If interpreted incorrectly, the monitoring data can suggest that the effect of the oil spill was minimal or that the spill in fact decreased the ambient deposition rate. The usefulness of beach monitoring data in oil-spill damage assessment could be increased by making the search protocols of monitoring programs and oil-spill response agencies more directly comparable.

BYCATCH OF WATERBIRDS IN MID-ATLANTIC COASTAL ANCHORED GILLNETS ESTIMATED FROM BEACHED-BIRD SURVEYS

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The U.S. Fish and Wildlife Service conducted a study of bird mortality in anchored gillnets in the nearshore ocean waters from New Jersey through Virginia during the spring of 1998. Beached-bird surveys and live-bird counts were important components of the study. Beached-bird surveys were conducted repeatedly from vehicles at 20 locations along the 565-km shoreline. Two hundred and ten (210) dead diving birds were found on 1,732 km of surveyed beach. Approximately ten times more dead birds were found on beaches within 2 km of gillnets than on beaches without nets. A minimal mortality estimate based on the beached-bird surveys is 1,265 diving birds/season. Ninety-two percent of 27 marked Red-throated Loons remained on the beaches less than 24 hours or one tidal cycle. Beached-bird surveys on beaches with steep banks may underestimate the mortality of medium-sized birds in areas with numerous large scavenging gulls. Experienced observers can also count gulls and shorebirds on beaches and count the birds in the near shore waters to 400 m providing additional

indexes to bird numbers. Birds were counted to 400 m offshore on 590 km of shore with nets deployed within 1 km and on 953 km of shore with no nets deployed. For all diving birds, birds/km were counted in waters without nets and 4.6 birds/km were counted in areas with nets.

DISTRIBUTION AND ABUNDANCE OF WINTERING WATERBIRDS IN MID-ATLANTIC WATERS TO 12 NAUTICAL MILES OFFSHORE: CONSERVATION AND MONITORING IMPLICATIONS

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We have only a limited knowledge of bird distribution and abundance beyond 500 m from shore in most mid-Atlantic waters. Marine birds face numerous hazards, including gillnet fisheries, oil spills, and overfishing of forage fishes. A relatively new impact on marine-bird habitats is sand mining for beach replacement. Due to large variability in bird usage of shoals and our limited understanding of their ecological linkages, we are unable to predict the impacts of sand mining. Another possible new impact is the proposed construction of thousands of large wind turbines in over thirty sites on continental shelf waters of the northeastern US. The winter distribution of most marine birds is strongly linked to their food resources. By understanding the feeding ecology of birds and the abundance of their food resources, we can identify critical offshore habitats. We suspect that large spring concentrations of scoters may be feeding on eggs or larvae of fish, such as menhaden, in preparation for migration. We recently completed winter aerial surveys in waters to 12 mi offshore from Virginia through northern New Jersey. Black Scoters, Surf Scoters, Northern Gannets, Common Loons, Red-throated Loons, and large gulls were the most abundant wintering birds. All bird groups were found to be more abundant over shoal waters than non-shoal waters.

LACK OF PROTECTION FOR MIGRATORY MARINE BIRDS FROM THE EFFECTS OF OFFSHORE OIL AND GAS ACTIVITIES ON THE GRAND BANKS, NEWFOUNDLAND

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Migratory species defy national boundaries and require international efforts for their protection. Because protection of migratory species requires international collaboration, it is important that nations sign and integrate the precepts of treaties designed to protect these species. We examine Canada's role in protecting migratory marine birds on the Grand Banks, Newfoundland. Specifically, we outline how migratory birds are placed at risk from offshore oil and gas activities, briefly discuss the treaties in place to protect them, and outline recommendations to assist Canada in adopting more effective stewardship of migratory birds and stronger leadership in setting the standard for international cooperation.

ARE FLIGHT-LINE COUNTS USEFUL FOR ESTIMATING NUMBERS OF NESTING WADING BIRDS? A FIELD TEST

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Resource managers need a rapid, non-invasive technique to census wading bird colonies. Direct counts are preferred but often are problematic, due to visibility bias, errors in nest identification, high manpower investment, and unacceptable disturbance effects. An alternative is to estimate colony size from the rates of birds arriving and departing the colony from observation points outside the colony (flight-line method). We measured flight rates of Great Egrets at five colonies in Florida where we could also obtain accurate counts of nests. We found a slightly positive, nonsignificant correlation between numbers of nesting Great Egrets and flight rate ($r^2 = 0.055$, $n = 20$ days). However, using only the data from the two colonies in Tampa Bay, a highly significant correlation was found ($r^2 = 0.903$). At the most synchronous colony (Seahorse Key), we found large effects of year, time of day, date, and nesting stage on flight rate. The flight-line method provides reliable information on species composition and nesting phenology. The level of accuracy in estimating numbers of nests may vary by location, year, stage of nesting, and time of day. Utility of this technique is probably greatest

during incubation and guard stage. Further study may allow refinements that improve the precision and consistency of the technique.

POPULATION GENETIC STRUCTURE AND CONSERVATION OF MARBLED MURRELETS

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Genetic data are needed to help delineate management units for Marbled Murrelets (*Brachyramphus marmoratus*). We compared variation in the mitochondrial control region, four nuclear introns, and three microsatellite loci among 194 murrelets from throughout their range. Results of several types of analyses on all three types of markers indicate that significant population genetic structure exists within this species: several control-region haplotypes and intron alleles were unique to the Aleutian Islands or California; global estimates of population structure were statistically significant, as were many pairwise estimates; and marked isolation-by-distance effects were found. Results indicate that Marbled Murrelets include at least four management units: (1) Aleutian Islands, (2) Alaska Peninsula, (3) Kodiak Island to British Columbia and possibly northern California, and (4) central and possibly northern California. The possibilities that the Aleutian Islands and California include two or more distinct populations each, the ecological exchangeability of tree- and ground-nesting murrelets, and the genetic affinities of murrelets in Washington and Oregon still need to be determined.

INTERANNUAL VARIATION IN DIET AND PRODUCTIVITY OF PLANKTON-FEEDING AUKLETS: CLUES TO THE EFFECTS OF CLIMATE CHANGE?

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We assessed the relationship of productivity to diet in Least Auklets (*Aethia pusilla*) and Crested Auklets (*A. cristatella*) by measuring breeding chronology, nest survival, and nestling diet composition at two colonies on St. Lawrence Island, Alaska, during the 2000–2002 breeding seasons. These three reproductive parameters varied in parallel among years for both auklet species, suggesting control by a common environmental factor. Median hatching dates for both species were two weeks earlier in the year of highest nest survival (2002) than in the two years of lower nest survival. Nestlings of Least and Crested auklets were fed more of the oceanic, high-lipid copepod *Neocalanus cristatus* in 2002 than in the two years of lower reproductive success. In contrast, during the year of lowest nest survival for both auklet species (2001), the neritic, low-lipid copepod *Calanus marshallae* was more prevalent in the diet of Least Auklets and the small copepod *N. flemingeri* was more prevalent in the diet of Crested Auklets than in the two years of higher nest survival. Sea ice-dependent advection of oceanic copepods far onto the shelf of the northern Bering Sea appears to be a key determinant of auklet nesting success at St. Lawrence Island. Auklet productivity and diet may serve as one component of the overall effort to monitor the impact of climate change on productivity of the northern Bering Sea.

A REVIEW OF COMMENSAL RODENT ERADICATIONS ON ISLANDS

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Introduced species are responsible for most bird extinctions and are the largest cause of seabird extinctions and endangerment. Commensal rodents (*Rattus* spp. and *M. musculus*) are the most widespread and damaging of the introduced mammals. They are directly responsible for an estimated 40% of global bird extinctions and the extirpation of many seabird populations. However, commensal rodents can be eradicated from islands, after which populations of native species can recover. We reviewed all known commensal rodent

eradications from islands to facilitate future island conservation actions. The complete data set can be found at <http://www.islandconservation.org/eradicationdb.html>. Globally, we found at least 274 commensal rodent eradication on 233 islands, mostly in Australasia. Most eradications (63%; $n = 173$) have occurred on small islands (<50 ha), while only 13 eradications (<5%) have occurred on islands >500 ha. The most common method of eradication has been poisoning with the second generation anticoagulant brodifacoum (64%; $n = 129$, eradications where data were available on methods). Impacts from commensal rodent predation and, more recently, the benefits of eradications have been increasingly documented. These impacts and benefits, combined with the continued success of eradication campaigns on larger islands, demonstrate the value and role of commensal rodent eradications in seabird conservation.

EVERY YEAR IS DIFFERENT: SEABIRD DISTRIBUTION AND ABUNDANCE ON THE HUMBOLDT CURRENT IN NORTHERN CHILE

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Seabird distribution has been studied on the Humboldt Current upwelling system in northern Chile during the breeding seasons 1998–1999 and 2001–2004. Counts were made on 300-m-wide transects from ships using the standardized northwest European methodology. Abiotic and biotic factors were studied simultaneously during the counts or at hydrographic stations set at regular intervals (e.g., water temperature, salinity, chlorophyll concentration, fishing vessel occurrence). More than 20 species were recorded in the study area. Abundances of species differed considerably between years, with Peruvian Booby, Kelp Gull, Humboldt Penguin, Wilson's Storm-Petrel, Antarctic Prion, and White-chinned Petrel representing the most abundant species. The composition of species was different in different areas of the upwelling system. Some species showed clear links to chlorophyll distribution, some species were related most clearly to hydrographic features and concentrated over cold, upwelled water, and other species were associated with the coastline and fishing trawlers. We furthermore found that the extent of multi-species feeding associations (MSFAs) varied very strongly between the different years. All results are set in relation to the El Niño–Southern Oscillation (ENSO) stages exhibited during the study period.

CENSUS AND MONITORING OF NORTHERN FULMARS IN THE CANADIAN HIGH ARCTIC [Poster]

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Census and monitoring of Northern Fulmars *Fulmarus glacialis* in the High Arctic of Canada was initiated in the 1970s, when the approximate size of most colonies was assessed and a detailed census was made of Prince Leopold Island. Repeat visits have been made to most colonies in the past 5 years, and more intensive counts made at several previously poorly-known colonies. As a result, we have obtained a more accurate estimate for Northern Fulmar populations in Canada, with the estimate for 2000–2003 in the region of 200,000 occupied sites. This is only 2/3 of previous estimates, but the difference is likely due to differences in estimation techniques. Trends at monitoring plots on Prince Leopold Island have shown no change over the period considered. Our results highlight the difficulty of censusing this species in the High Arctic.

FORAGING BEHAVIOUR OF THICK-BILLED MURRES IN RELATION TO PREY TYPE

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We deployed time-depth/temperature recorders on Thick-billed Murres *Uria lomvia* rearing chicks at Coats Island, Nunavut in 2004. Through round-the-clock watches at their breeding sites, we were able to recognise the prey delivered to chicks. Temperature records allowed us to distinguish time on the water from time in the air, while observations at the colony recorded times of arrival and departure. Hence, we were able to estimate foraging distances from the duration of incoming flights. We examined the final dives before the bird returned to the colony with an identified prey item to distinguish different patterns of hunting behaviour associated with different prey. When repeated flat-bottomed dives reached the same depth, we assumed that

birds were feeding at the sea bed. When dives were V-shaped, and successive dives went to irregular depths, we assumed that birds were feeding in mid-water. We describe how dive behaviour and trip distance vary with prey species.

SPATIAL RELATIONSHIPS OF RADIO-MARKED MARBLED MURRELETS AT SEA DURING THE BREEDING SEASON

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At-sea locations of radio-marked Marbled Murrelets ($n = 102$) were monitored daily with fixed-wing aircraft along the coast of northern California during April–July, 2001–2003. Murrelets were captured within 20 km of the mouth of Redwood Creek, which was a major watershed containing nests and old-growth trees. Murrelets foraged an average of 17 ± 2.8 , 21.1 ± 2.8 , and 27 ± 2.1 km from the mouth of Redwood Creek in 2001, 2002, and 2003, respectively. The position of each bird was compared with each neighbor on each day using geographical information systems techniques. We also compared distances between sequential locations for each bird across days and between all locations across all days. Marked pairs with nests exhibited distinct changes in their patterns of association through the breeding cycle. Marked individuals were seldom found in consistent association with other marked individuals. Murrelets were generally closer to nearest neighbors than to their preceding locations and probably were exploiting patchily distributed prey. We observed fidelity to specific foraging locations over short time frames. Murrelets appeared to forage on patchily distributed prey for a few days in the same general location but moved to new foraging sites over time. Nesting murrelets were closer to nearest neighbors, had shorter distances between sequential locations, and had shorter distances to all locations. Nesting murrelets also foraged at shorter distances to Redwood Creek than did non-nesting murrelets. Foraging sites appeared to be constrained by distance from the nest.

LIMITS TO DETECTION: PIT-TAG SURVEYS, CASPIAN TERN COLONIES, AND ESTIMATING PREDATION ON ESA-LISTED SALMONIDS

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Electronic recovery of Passive Integrated Transponder (PIT) tags is used extensively to assess predation by piscivorous waterbirds on threatened and endangered Columbia River Basin salmonids. Predation estimates based on PIT tag detection are generally regarded as minimal estimates; one reason is that PIT tag readers cannot detect PIT tags in proximity to one another due to electronic interference between tags. However, the potential magnitude of such interference on estimates of avian predation has not been studied. At a Caspian Tern breeding colony in the Potholes Reservoir in central Washington, we scanned 122 nests for PIT tags, detecting only 15 tags. When we subsequently excavated nest cups, we recovered 1,356 tags, detecting 100%, 50%, 33%, 25%, and 0% of tags in nests containing 1, 2, 3, 4, and ≥ 5 tags, respectively. While individual nests contained from 0–68 PIT tags, 68% of nests contained ≥ 5 tags, accounting for 99% of tags recovered. We are currently determining the percentage of PIT tags recovered between nests that were electronically detected. The magnitude of the difference in detection rates between tags scanned versus physically recovered likely differs among colonies; however, our results emphasize the necessity of addressing electronic interference between PIT tags when using data collected electronically to assess avian predation.

TRACING NUTRIENT ALLOCATION TO REPRODUCTION IN A SUB-ARCTIC BREEDING BIRD: INFERENCE FROM PROXIMATE AND STABLE-ISOTOPE ANALYSES

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The use of endogenous reserves as a source of nutrients for egg production (i.e., a capital breeding strategy) has received much attention in the waterfowl due to the high energetic and nutritional costs of egg production. Traditional approaches for quantifying the use of endogenous reserves during egg production in waterfowl have relied on indirect methods of tracing nutrient allocation such as proximate body-composition

analyses. Stable-isotope analyses allow for the direct tracing of both endogenous and exogenous sources of nutrients used in egg production and can provide quantitative estimates of the relative contributions of both sources. Using these two approaches, we traced nutrient allocation to reproduction in female Greater Scaup breeding on the Yukon–Kuskokwim Delta, Alaska, with particular emphasis on the relative contribution of endogenous reserves in relation to date of rapid follicle growth (RFG) initiation. Body-composition analyses indicated that early and late RFG initiating females do not use endogenous lipid and protein reserves to meet the demands of egg production; they appear to rely on daily dietary intake into egg lipid and protein. These results were corroborated with stable carbon and nitrogen isotope analyses, including quantitative mixing models and correlation analyses, where isotope signatures of reproductive lipid and protein were reflective of local breeding area food resources. Our results suggest that female Greater Scaup differ from most other high-latitude breeding waterfowl in utilizing an income breeding strategy.

THIRTY YEARS OF ANALYSING AND MODELING AVIAN HABITAT RELATIONSHIPS USING SATELLITE IMAGERY DATA: A REVIEW [Poster]

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The application of Remote Sensing and Geographic Information Systems (GIS) technologies provides powerful tools when used to investigate wildlife and its habitat for an analysis or modeling approach. Birds have been of great and progressive value as biological and environmental indicators. In order to learn about the common approaches used-its methods, processing steps, trends, advantages, and challenges-we reviewed over 120 representative publications of the last 30 years that made use of satellite images for avian applications. The reviewed studies have shown that, so far, Landsat TM (61%), additional environmental data (36%), Point-Stop Count (53%), and multivariate statistics (53%) were applied within a large range of scales and habitats. To improve the quality of inference and for comparative analyses, we recommend to document studies in high detail. To verify and improve the obtained results, additional ground data on the main structure of the vegetation relevant to the bird species in question are usually necessary. Satellite-based RS applications in ornithology could be used increasingly for assisting in habitat evaluation, modeling, and monitoring and in achieving overall wildlife conservation and management objectives effectively, especially in inaccessible regions of the world.

LEAPFROG MIGRATION IN MARBLED GODWITS AND WESTERN WILLETS?

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Leapfrog migration, where populations from farther north winter south of temperate populations of the same species, has not been reported for Marbled Godwits or western Willets. This paper examines evidence for leapfrog migration in these species. From 1995 to 2000, 111 Marbled Godwit and 205 Willet adults were captured on nests in Alberta and uniquely color-banded. Fifty-nine sightings were reported away from the breeding grounds. The 52 godwit sightings represented 16 individuals (14% of those marked), and the 8 Willet sightings represented 5 individuals (2% of those marked). Birds were reported only from California and México (Baja California). Only one bird, a female godwit, wintered in California; all other California sightings were migrants. All Mexican sightings, including 5 individual godwits and 3 Willets, were of wintering birds. Although about 40,000/180,000 Marbled Godwits winter in California, and far more people search for marked shorebirds there than in México, five times as many Alberta godwits were seen in México. This suggests that California godwits have a breeding origin elsewhere, possibly in the US Great Plains. Few Alberta Willets were observed elsewhere; none were wintering in California, and three were seen in México. In contrast, in another study, many breeding Willets marked in Oregon and California were seen wintering in southern California. Apparently, Alberta Willets winter farther south, in México or Central/South America.

COMPARISON OF LINE-TRANSECT AND ADAPTIVE-CLUSTER SAMPLING TECHNIQUES FOR DETECTING NOVEL WATERBIRD COLONIES DURING AERIAL SURVEYS

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We conducted aerial surveys using two sampling methods, line transect and adaptive cluster, in search of novel waterbird colonies over an extensive forested wetland, the Atchafalaya Basin. Line transects are often used to survey waterbird colonies, while adaptive cluster is a novel approach that may be better for sampling targets of interest that are spatially clumped. We conducted random line-transect (strip-transect) surveys using 10-km transects with a fixed half-width of 500 m. For the adaptive-cluster survey, initial sampling units (clusters) were surveyed in a circular fashion with 500-m radius. The presence of a waterbird colony in the initial cluster resulted in the sampling of the adjacent north, east, west, and south cluster (neighborhood). We located nine and eight colonies with the adaptive-cluster and strip-transect methods, respectively. Both sampling methods estimated similar total number of colonies for the Atchafalaya Basin. Strip-transect and adaptive-cluster sampling both appeared to be appropriate for conducting searches for novel waterbird colonies. However, the colonies surveyed were clumped spatially, suggesting that adaptive cluster may be preferred in certain habitats. Comparisons with other habitat types (e.g., marshes) are important to determine the general utility of either sampling method for surveying waterbird colonies.

INFLUENCE OF WETLAND HYDROPERIOD ON FOOD AVAILABILITY FOR SPRING MIGRATING WATERFOWL [Poster]

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The relative importance of spring flooded seasonal wetlands to spring migrating waterfowl has received little attention. We hypothesized that the timing of initial flooding influences seed biomass availability during spring by influencing the extent of seed depletion during fall migration. We conducted an experiment to test the prediction that seed biomass in spring is higher in spring-flooded than fall-flooded seasonal wetlands. First, we selected two wetland units at each of five managed wildlife refuges and assigned one to the treatment group (flood in spring) and the other control group (flood in fall). We collected samples ($n = 20$) in each prior to waterfowl arrival in fall, and in late winter, prior to spring migration. Second, we placed exclosures in treatment units ($n = 20$ /unit) to determine how predation by terrestrial seed predators influenced over winter seed loss from spring-flooded wetlands. Mean over-winter depletion was greater in fall-flooded (–80%) than spring-flooded (–30%) wetlands. Spring biomass estimates were similar inside vs. outside exclosures, indicating that loss of seeds to terrestrial predators was limited. Our results indicate that keeping seasonal wetlands dry through winter and flooding prior to spring migration can increase seed biomass available for spring-migrating waterfowl.

MESO-SCALE ASSOCIATIONS AMONG MARINE BIRDS, JUVENILE SALMONIDS, AND MARINE FORAGE FISHES FROM COASTAL AND SHELF WATERS OF OREGON AND WASHINGTON [Poster]

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Marine forage fish are thought to provide abundant prey to seabirds that might otherwise target protected juvenile salmon species in Washington and Oregon. However, there is no direct information on spatial overlap between fish species and seabird distributions in the nearshore ocean environment. To identify the potential for trophic interactions between seabirds, juvenile salmonids, and marine fishes, we compared seabird surveys to fisheries surface trawls along the same transects in May and June 2003 and 2004. Common Murre (*Uria aalge*) and dark shearwaters (*Puffinus griseus* and *P. tenuirostris*) were the most abundant seabird species in all surveys. Pacific sardine, northern anchovy, and Pacific herring were the most common forage fishes caught in surface trawls. Results address the overlap of seabirds, endangered salmonids, and marine forage fishes in the nearshore and shelf environment, especially around the Columbia River plume.

BREEDING-SEASON SPATIAL REQUIREMENTS OF GREAT LAKES PIPING PLOVERS

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The population of Piping Plovers in the Great Lakes region is endangered at state and federal levels. To protect nesting habitat adequately, it is important to understand spatial and temporal movements of breeding individuals. We determined home-range sizes and linear shoreline length traversed for 35 individually color-banded breeders from May to August, 2003 and 2004. We examined relationships between spatial movement and nest stage (incubation vs. chick-rearing), sex, age, predominant substrate type, public-beach use, and nearest-nest distance. Mean home range size was 0.35 km², and mean linear distance traversed was 0.64 km. Individual home-range sizes and linear-distances traveled varied between individuals, sites, and years. No significant relationships were found between nest stage, sex, age, substrate type, and home-range size or linear distances. Home-range size for plovers nesting on high-public-use beaches was greater than those nesting on medium- or low-public-use beaches in 2003 ($P < 0.05$). Linear distance traveled increased as proximity to other plover nests increased ($P < 0.05$) in 2004. These results indicate that individual breeders use different amounts of space and that extrinsic factors such as number of plover pairs in the area or public-beach use may influence spatial movements.

USE OF MOLECULAR MARKERS IN WATERBIRD RESEARCH AND CONSERVATION

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[No abstract was received.]

UNDERSTANDING SEABIRD INDIVIDUAL MOVEMENT PATTERNS TO ASSESS VULNERABILITY TO BYCATCH IN GILLNET FISHERIES

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Seabird bycatch has been reported in coastal gillnet fisheries in Washington and British Columbia. As is typical for long-lived species with low reproductive output, seabird populations are very sensitive to slight increases in adult mortality. Common Murres (*Uria aalge*) compose 75% of the reported annual bycatch both in WA and BC. However, there is no information on the provenance of these birds, i.e., whether they migrated from Washington or Oregon, where colony attendance may differ by up to two orders of magnitude. We assessed whether Common Murres from Tatoosh Island—the largest colony in WA and the closest to the fisheries—are vulnerable to bycatch and, if so, to quantify their vulnerability. A vulnerability index, based on the degree of spatio-temporal overlap between murres and the fisheries abundance and distribution, is attributed to both individuals and fishery management units. To gain insight about how to build the best index models, I am quantitatively describing individual bird movements, derived from radio-telemetry data. In what direction are they going? Is speed constant over time? Do they travel through fisheries areas, and at the right time to be at risk of bycatch? These models will help gain insight about whether mortality in gillnets represents a conservation issue for Common Murres on Tatoosh Island.

MARINE RADAR AS A TOOL FOR MONITORING XANTUS'S MURRELET POPULATIONS

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Xantus's Murrelets (*Synthliboramphus hypoleucus*) are one of the seabird species most vulnerable to imminent extinction due in part to high mortality rates from introduced ground predators at nesting colonies. Black Rats (*Rattus rattus*) were eradicated from Anacapa Island, California, in an effort to restore seabird populations. Using a modified marine radar system mounted on a boat, we conducted nocturnal surveys and counted the numbers of birds flying into or out of potential nesting habitats at Anacapa Island during the April–May breeding season from 2000 to 2003. In 2000, we sampled from dusk to dawn, allowing us to determine the periods of the night and zones of activity to sample that yielded the lowest variation in counts. We used these

data to develop a population-monitoring method and refine a long-term monitoring program. We also used radar to locate new nesting colonies, assess their relative sizes, and map congregations of nest sites. We found vessel-based radar monitoring to be an efficient tool for estimating nesting activity levels and monitoring populations of Xantus's Murrelets, and we discuss its future application in monitoring programs.

DIVING CHARACTERISTICS OF XANTUS'S MURRELET FORAGING NEAR ANACAPA ISLAND, CALIFORNIA [Poster]

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We monitored diving of Xantus's Murrelets near Anacapa Island during the breeding season in 2003 with radio telemetry. Radio-transmitters ($n = 44$) were attached to murrelets captured near Anacapa Island, and we monitored telemetry signals that could be detected from the island (within 5 km) with a hand-held antenna and receiver. Radio-marked murrelets were monitored for 29 h in three separate time periods in April and May. We found a lack of correlation between dive-duration and time on the surface between dives for individual murrelets (ANCOVA, $F = 1.34$, $n = 16$, $P = 0.18$) and for the three time periods (ANCOVA, $F = 0.91$, $n = 3$, $P = 0.41$) overall. The lack of correlation between mean dive-duration and time on the surface within a dive bout for individual murrelets (ANCOVA, $F = 0.10$, $n = 5$, $P = 0.98$) indicated that they were not diving to maximal depth or maximizing the amount of time underwater to obtain prey. The short mean dive duration in each of the three time periods (mean = 18, 29, 24 s) suggested that murrelets were diving to capture prey within 20 m of the surface near Anacapa Island.

AN ANALYSIS OF FACTORS INFLUENCING BEACHED-BIRD COLLECTION DURING THE LUCKENBACH 2001–2002 OIL SPILL

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Spanning 223 miles of coastline and four months, the response to the *Luckenbach* oil spill of winter 2001–2002 included one of the largest efforts to collect beachcast birds in history. Using a data set that includes 2,472 beach searches and 1,928 collected birds, this analysis examines several factors that influenced the recovery of both live and dead birds. These factors include: method of search (e.g., foot, vehicle, or scan), rate of search, agency affiliation (e.g., Trustee agency or wildlife rehabilitation agency), and timing and locations of searches. We found that 41% of the coastline was never searched due to inaccessibility and that oiling rates by species were strongly correlated with pelagic foraging behavior. We conclude that beach accessibility, rather than bird encounter rates, most determined search effort. Second, we found no evidence to support the perception that wildlife rehabilitators were less likely to find birds already dead. Third, although the public collected 43% of all live birds, their "search effort" was disproportionately on weekends at certain locations. These results may be useful for modifying response strategy and may also be applied to a Beached-Bird Model for total bird-mortality estimation.

REPORT ON THE ABUNDANCE AND DISTRIBUTION OF MARBLED MURRELETS IN NEARSHORE COASTAL AREAS OF PACIFIC RIM NATIONAL PARK RESERVE, BRITISH COLUMBIA, CANADA [Poster]

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We began a formal Marbled Murrelet at-sea monitoring program in 1999, which continues to the present. This followed on pilot at-sea surveys in the greater Pacific National Park Reserve (PRNPR) ecosystem conducted in PRNPR during 1991–1996. The surveys have been conducted by Resource Conservation staff every 2 weeks between May and September every year since 1999. The data from the past 6 seasons of surveys in PRNPR (1999–2004) have been entered into a seabird database developed for the park. We looked at the spatial and temporal distribution and relative abundance of Marbled Murrelets in nearshore areas of Barkley Sound and in the West Coast Trail Unit of PRNPR. The analysis results are depicted in Geographical Information System (GIS) mapping and in graphs.

VARIABLE PREY ABUNDANCE AND ADJUSTMENT OF PARENTAL EFFORT: FLEXIBILITY OF ADULT TIME BUDGETS IN THE COMMON MURRE [Poster]

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An understanding of ecological factors that influence parental time budgets is important for predicting species-specific responses to changing environmental conditions. Common Murre (*Uria aalge*) parents share incubation and brooding duties equally, with one parent attending the egg or chick at all times. Common Murres have flexible time budgets, especially in allocation of time spent at the nest-site by the off-duty parent. The relationship between food availability and time spent at the colony by breeding seabirds was predicted to be non-linear, with time spent at the colony diminishing rapidly below a threshold of food availability as parents spend more time foraging. Several studies have demonstrated that the off-duty parent spends more time at the colony when food is abundant, but the functional relationship between food supply and colony attendance of murres has not been examined. Also, a threshold response has not been demonstrated. We examined temporal (seasonal and annual) and spatial (among-colony) variability in parental time budgets of Common Murres using 4–6 years of data from three colonies characterized by markedly different oceanic conditions and levels of prey abundance. Overall, the response was sigmoidal, and birds spent the least amount of time at the colony that had the lowest food availability. Time spent at the colony is examined in relation to ecological and physiological constraints on parental behavior.

THE SEABIRD ECOLOGICAL ASSESSMENT NETWORK (SEANET): CITIZEN SCIENTIST AND VETERINARY STUDENT INVOLVEMENT IN BEACHED-BIRD SURVEYS

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Numerous threats contribute to the mortality of seabirds and waterbirds, such as disease, fisheries operations, persistent organic pollutants and metals, and oil pollution. While ongoing beach-monitoring projects in Atlantic Canada have detected significant chronic oiling problems, the Atlantic coast of the United States has not been recently monitored for seabird mortality. In 2002, we initiated the Seabird Ecological Assessment Network (SEANET <http://www.tufts.edu/vet/seanet/>) to implement beached-bird surveys in the northeastern US. SEANET is a large-scale, collaborative program focusing on seabirds as indicators of marine and coastal ecological health, involving wildlife rehabilitators, veterinarians, bycatch observers, and other groups. In addition to collecting data on seabird mortality, the network seeks to develop and compile information on population distribution, ocean contamination, and coastal land use. In order to document causes of mortality that are undetectable by external observation, we conduct necropsies, a component of the project that also serves as an educational opportunity for veterinary students. We are developing a network of veterinarians and wildlife rehabilitators who will be archiving specimens and conducting necropsies to develop our knowledge base about the incidence of such threats as marine-debris ingestion, internal oiling, and disease prevalence.

HAYFIELDS IN THE AMERICAN WEST: CRITICAL HABITAT FOR HIGHLY IMPERILED LONG-BILLED CURLEWS

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The Long-billed Curlew (*Numenius americanus*) is one of the most threatened shorebird species in the United States. It is categorized as “highly-imperiled” under the US Shorebird Conservation Plan and is listed as a species of conservation concern at the national level. These listings are based on substantial loss and degradation of breeding and wintering habitat and a dangerously low global population estimate. In certain areas of the American West, traditional cattle operations depend on the production of wild hay, a situation beneficial to breeding Long-billed Curlews. Early in the breeding season, hayfield vegetation is short, providing ideal nesting habitat for arriving curlews. Later, the tall grass of hayfields provide brooding habitat, and, since field-mowing occurs late in the season, there is no conflict with flightless chicks. We studied a population of

Long-billed Curlews breeding in Ruby Valley, Nevada, hayfields. Ruby Valley has one of the densest assemblages of breeding Long-billed Curlews ever recorded, with an estimated breeding density of over 5 pairs/km². Nest success was similar among years (~29%); yet fledging success was highly variable. Curlews breeding in Ruby Valley re-nest following loss of their first clutch, a phenomenon not observed in any other Long-billed Curlew population. Maintaining viable ranching operations and wild hayfields is critically important to Long-billed Curlew conservation.

BEHAVIOURAL STRATEGIES OF AQUATIC BIRDS: NECESSITY OF A MULTI-SCALE APPROACH

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Dynamic physical processes in aquatic environments influence environmental conditions and generate patchiness over a range of spatiotemporal scales and trophic levels. This variation can influence foraging tactics of avian predators. Predator morphology, physiology, and energetic constraints can also affect behavioural responses to environmental variation. These constraints act over a range of time scales and can include short-term oxygen balance (e.g., for diving birds), longer-term cardiovascular limitations, and digestion. Interactions between these biotic and abiotic factors can lead to complex multi-scale patterning of behaviour by birds exploiting aquatic environments. Yet, for the most part, behavioural sampling, analysis, and modeling have typically only considered single time-scales, often assuming that short-term observations and foraging currencies can be directly scaled up to longer periods and fitness. We use foraging data on Harlequin Ducks wintering in Newfoundland and Common Eiders wintering in the Canadian Arctic to illustrate that observed patterns of foraging effort can be scale-dependent. Observations of foraging effort can vary, often oppositely, depending on the temporal scale of investigation, precluding extrapolation and generalization. We discuss the importance of a multi-scale approach to quantifying and modeling behaviour and for understanding the variety of mechanisms and factors important to the foraging ecology of aquatic birds.

THREESOMES AND NEST-SITE FIDELITY IN MARBLED MURRELETS

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During a 2001–2003 radio-telemetry study of the nesting biology of Marbled Murrelets (*Brachyramphus marmoratus*) in Redwood National and State Parks in northern California, we video-recorded the presence of three Marbled Murrelets simultaneously at one nest-site on two separate occasions. This nest-site has been used for breeding in four consecutive years from 2001–2004. Nest-site fidelity between years was also observed at two other nest sites. The presence of extra-pair birds at active nest-sites, together with nest-site fidelity, may suggest that nest-sites are limiting for Marbled Murrelets in northern California, some murrelets may pair with a different mate between years at the same nest-site (with or without mate death), or prospecting and pairing behavior by non-breeding individuals may involve visitation of other active nests.

SO A FEW BIRDS GOT OILED? WHAT'S THE BIG DEAL?

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The regulations promulgated to implement the Oil Pollution Act (OPA) state that the goal of OPA is to make the public and environment whole for injury to natural resources. OPA directs the natural-resource Trustees (selected Federal Departments, all States, and most Indian Tribes) to accomplish that goal by recovering damages for injury to natural resources and conducting restoration. Furthermore, the regulations specify that restoration actions should return the injured natural resources to the conditions that would have existed, had the incident not occurred. Oil spills can cause substantial mortality to migratory birds, but quantifying the magnitude of the injury and converting that into a damage claim can be difficult. Using case-specific examples, we will discuss how natural-resource Trustees translate beached-bird injury data into a damage claim for restoration; how industry representatives use these same data to reduce a damage claim; which

beached-bird data tend to be the focus of disputes between the Trustees and industry; and what steps can be taken to modify future beached-bird data-collection efforts to reduce the degree of controversy.

REVIVING A NATIVE PLANT COMMUNITY AND REDUCING EROSION IN DEGRADED BURROWING ALCID HABITAT ON AÑO NUEVO ISLAND, CALIFORNIA

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Año Nuevo Island, California, has a complex history of habitat disturbance and wildlife exploitation. Rhinoceros Auklets (*Cerorhinca monocerata*) began colonizing the island in the early 1980s, in marine-terrace soil dense with vegetation of mainly exotic species. After 1997, the main nesting habitat degraded further and became completely denuded. The proportion of burrows that collapsed due to soil erosion during the nesting season increased from 11% (1997) to 56% (2001). The purpose of this restoration project is to revive a native plant community and improve soil stability in burrow-nesting areas. To determine appropriate plant species and restoration techniques, ten test plots were monitored in 2001 and 2002. In November 2003 and 2004, the main auklet habitat (0.4 ha) was stabilized with a combination of mature native grasses (salt grass *Distichlis spicata* and American dune grass *Elymus mollis*), native seeds (e.g., beach bur *Ambrosia chamissonis* and lizardtail *Eriophyllum staechadifolium*), and erosion-control applications. After these treatments, in the following 2004 breeding season, vegetation percent cover increased to 29% (May) and 21% (July). Future studies will quantify habitat changes, evaluate restoration techniques, and investigate ecosystem response through 2010. Restoration techniques successful on Año Nuevo Island may be applicable elsewhere, as numerous islands suffer from habitat degradation.

THE SHETLAND BEACHED-BIRD SURVEY, 1979–2003

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Monthly beached-bird surveys have been conducted in Shetland, Scotland, since March 1979 as part of a programme of monitoring the environmental impact of the Sullom Voe Terminal, one of Europe's largest crude oil exporting facilities. The aims are to monitor chronic oil pollution and patterns of natural mortality affecting seabirds in the seas around Shetland, to detect trends, and to place instances of abnormal mortality in a long-term context. More recently, samples of oil have been collected routinely for analysis. Presently, 50 km of coastline are surveyed monthly by professional biologists and amateur volunteers, and the data set since 1979 composes 58,630 seabird corpses collected from 15,140 km of beach. This paper examines trends in chronic oil pollution over 25 years and discusses the efficiency of operational measures to reduce it and changes in the types of oil found. A high rate of oiling in the early 1980s became reduced and more sporadic, while, for the past six years, oiling rates have been very low. Changes in non-oiled mortality of alcids and other seabirds are described, both in winter and late-summer. Lessons were learned from deficiencies in the early years of the survey; the current situation in terms of coverage, manpower, analyses and publication is described; and suggestions are made for further improvements, both within the Shetland survey and the British Isles generally.

RESPONSES OF ANCIENT MURRELET POPULATIONS TO REMOVAL OF INTRODUCED PREDATORS IN HAIDA GWAI, BRITISH COLUMBIA

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We surveyed the Ancient Murrelet colonies on Langara Island and in Englefield Bay, British Columbia, in summer 2004 to assess how populations have responded to the removal of introduced rats (Langara) and raccoons (Englefield). At Langara Island, which historically may have been the largest Ancient Murrelet colony in the world, rats were removed in the mid 1990s, but follow-up surveys in 1999 and now 2004 have found little evidence of population change almost a decade after the eradication campaign. Raccoons, which arrived on several colonies in Englefield between 1986 and 1993, were removed from Helgesen Island in 1994, but surveys in 2004 found little evidence of population recovery there either. On nearby Lihou Island, which was never

invaded by raccoons, Ancient Murrelet populations remained more or less stable over the same period. The lack of response in Ancient Murrelet populations is of concern because Haida Gwaii supports a large proportion of the world population (50% by some estimates).

STABLE-ISOTOPE APPLICATIONS TO STUDIES OF MARINE-ASSOCIATED BIRDS

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The measurement of naturally occurring isotopes of several elements (e.g., C, N, S, H) in marine-bird tissues and their prey has provided significant new insights into how individuals and species fit into marine foodwebs. Such developments have had far-ranging influence on our understanding of contaminant flow, foraging dynamics, and, more recently, allocations of nutrients to reproduction. In addition, isotope techniques have provided direct evaluation of the effects of introduced predators onto seabird islands. Here, I will provide a brief overview of the scope of isotopic applications to studies of the ecology of marine and marine-associated species and so introduce this session.

THE OCCURRENCE OF CHLORINATED FATTY ACIDS IN SEA DUCKS FROM THE ALEUTIAN ISLANDS NEAR AREAS OF SEWAGE AND SEAFOOD WASTE DISCHARGES

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Chlorinated fatty acids (CFAs) are unique fatty acids capable of reducing sperm motility, inducing apoptosis, inhibiting cell growth, and for which exposure is correlated with adenosine triphosphate (ATP) leakage from the cell cytosol. In contrast to organochlorine contaminants, CFAs are found in greater concentration and diversity in phospholipids rather than neutral lipids. Since chlorinated fatty acids are not detoxified or eliminated by common mechanisms such as the cytochrome P450 pathway, there is potential for the organism to accumulate CFAs over their lifespan. Although CFAs have been investigated in various marine species of fish, invertebrates, and mammals, their occurrence in birds has never been explored. We have detected chlorinated fatty acids in heart, breast muscle, and liver samples obtained from Harlequin Ducks, *Histrionicus histrionicus*, from nearshore marine areas receiving inputs of sewage and seafood processing waste. Threshold levels for effects of CFAs in avian species are unknown. Like most other sea ducks, Harlequins live longer and have a lower reproductive frequency than dabbling ducks. Their long lifespan creates the potential for bioaccumulation of CFAs, which may have significant effects on health and reproduction.

“STEADY STATE” ECONOMY, SEABIRDS, AND HABITATS: AN OVERVIEW OF ISSUES TOWARD A SUSTAINABLE FUTURE [Poster]

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“Steady-State” presents an economic paradigm that seriously affects economic growth, resource extraction, and the sustainability of land- and seascapes, and thus, seabird habitat. It is widely known that seabirds reflect the conditions of their habitat and, therefore, can act as indicators of the marine environment. Here, we first will present an overview of global issues centered around the state of seabirds and their habitats. Second, we will introduce the concept of “Steady State Economy” and how it applies to seabirds, fisheries, and the marine environment. Third, we will present selected case studies where we show how the paradigm of economic growth would affect seabirds and their habitats a hundred years from now. Methods and findings from this project are used to develop reliable approaches and conservation management tools for projecting such effects on seabirds and their habitats in the future. Seabird and habitat responses to economic activities by humans are manifold and can result, for instance, in species endangerment as well as in exploding populations, short-term habitat enrichment, and long-term habitat devastation. Recommendations and an outlook are given on how to overcome the projected problems and how to maintain the sustainability of seabirds and their habitats.

FISHERIES, SEABIRDS AND OCEANOGRAPHY IN THE SEA OF OKHOTSK, RUSSIAN FAR EAST: A BASIC QUALITATIVE ASSESSMENT FROM 7 YEARS OF FIELD WORK [Poster]

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The Sea of Okhotsk is an important water mass in the northwestern Pacific. It is a highly productive zone, provides oxygen-rich deep water to the Pacific currents, and is, for large parts of the year, covered with ice. Despite recent interest by western ecotourism and oil industry in the area, many of the seabird and sea mammal resources are not well described to the western world. The area is already heavily used by the international fisheries fleet. Here, we present an overview from our literature review and working seven field seasons in the Oblasts of Kamchatka, Magadan, Sakhalin, and Kurile Islands. At these locations, extensive coastal surveys were carried out to describe and quantify seabird communities and their habitat. We present percentages of gull species and age class distributions in roosting flocks, migration patterns, seabird species located in coastal waters, and coastal predators. Our findings contribute to the biodiversity information of this extensive region and suggest that fisheries play a large role in shaping the ecosystem. Additional potential threats exist, such as offshore oil development, plastic pollution, and mining in watersheds. Research suggestions are made to put this relevant, but poorly studied, location on the “international biodiversity map.”

POPULATION STATUS AND HABITAT MODELING OF MARBLED MURRELETS IN THE AREA OF THE NORTHWEST FOREST PLAN

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The Northwest Forest Plan is a large-scale ecosystem management plan for federal lands in the Pacific Northwest. Marbled Murrelet (*Brachyramphus marmoratus*) populations and habitat were monitored to evaluate effectiveness of the Plan. Marbled Murrelets were sampled from boats using line transects within 8 km of the Washington, Oregon, and northern California coastline, covering ~8,800 km². From 2000–2003, the highest population was in Washington, in the Puget Sound and Strait of Juan de Fuca, the highest density was along the Oregon coast, and the lowest population and density was in northern California. Marbled Murrelet population estimates did not change significantly over 4 years. We estimated that 15 years of surveys will be needed to detect a 2% annual decrease with 95% power. We used three modeling approaches to estimate the amount and distribution of nesting habitat: expert judgment, ecological niche-factor analysis, and logistic regression. Most of the suitable nesting habitat on federal land is currently in reserved land allocations. Habitat models predicted that Marbled Murrelets are more likely to nest closer to the coast and in areas topographically cooler and flatter, with high basal area of conifer trees >75 cm DBH.

MORTALITY AND BEHAVIOR OF WESTERN SNOWY PLOVER CHICKS IN HUMBOLDT COUNTY, CALIFORNIA

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Young of ground-nesting, precocial birds are especially vulnerable to predation and human disturbance prior to fledging, with most mortality occurring early in the period. I monitored daily survival of the federally-listed Western Snowy Plover (*Charadrius alexandrinus nivosus*) at four sites in Humboldt County, CA, during 2003 and 2004. Eighty-one percent of chick mortality occurred in the first 10 days of life. Survival rates increased with chick age and were significantly higher for chicks reared in riverine gravel bar habitats compared with sandy ocean beaches. The percentage of time brooding decreased with age, but even nearly fledged chicks were occasionally brooded by adults. Faced with human approach, many young (1–10 d) plover chicks responded by crouching and remaining motionless, whereas older (11–28 d) chicks were more likely to move quickly away from approaching danger. Young plover chicks are particularly vulnerable on ocean beaches, where human recreational use conflicts with conservation efforts to recover the species.

POST BREEDING MOVEMENTS AND HABITATS OF THE BLACK-FOOTED ALBATROSS [Poster]

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The Black-footed Albatross (*Phoebastria nigripes*) is susceptible to bycatch in domestic and foreign longline fisheries across the North Pacific Ocean. While large population declines have been projected using fishing effort and bycatch estimates, very little is known about the movements and threats faced by individual albatrosses at-sea, especially during their post-breeding dispersal. To investigate Black-footed Albatross distribution, habitat-use, and overlap with longline fisheries, we tracked the movements of nine birds (4 females and 5 males) using 54-g ARGOS transmitters. The birds were caught at-sea within the Cordell Bank National Marine Sanctuary, off central California, and tracked from July to October 2004. We obtained location data for an average of 45 days (range 34–58 d for 5 continuous tags; 32–58 d for 4 tags on 24 hr on/24 hr off duty cycle). Seven of the tracked individuals departed Cordell Bank in a southwest direction and then looped back towards northern latitudes (45–50°N), with the other two birds remaining farther south (20–30°N). All of the satellite-tracked birds ventured beyond the US Exclusive Economic Zone, with three of them traveling west of the International Dateline. Our results suggest that post-breeding Black-footed Albatrosses do not remain within sanctuary waters but instead range widely across areas targeted by pelagic longline fisheries.

CLIMATE CHANGE AND MURRES: A CIRCUMPOLAR SEESAW

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Data on murre population trends from 52 colonies, involving more than 490 colony-years, from around the world were brought together for a circumpolar perspective of the effects of climate change on seabird populations. Circumpolar changes in Common and Thick-billed murre populations over the past 25 years were associated with decadal shifts of northern hemisphere atmospheric oscillations, the Pacific Decadal Oscillation and the North Atlantic Oscillation. These oscillations are correlated with decadal changes in ocean temperatures. The long-term sea surface temperature (SST) trends in the northeast Atlantic and the northeast Pacific mirrored each other resulting in a “seesaw” effect. When the northeast Atlantic cooled, the northeast Pacific warmed, and *vice versa*. Murre populations were in a constant flux: when SST shifted slightly (<~0.5°C), either positive or negative, murre populations increased, but when the shift was large (>~0.5°C), murre populations declined. The two species reacted somewhat differently to SST shifts. Thick-billed Murres, the arctic-adapted species, did better when the SST increased slightly, and the more temperate Common Murre did better when the SST decreased slightly.

SITE FIDELITY AND THE DEMOGRAPHIC IMPLICATIONS OF WINTER MOVEMENTS BY A MIGRATORY BIRD: THE HARLEQUIN DUCK

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Understanding the degree of demographic connectivity among population segments is central to the fields of population ecology and conservation biology. However, delineating demographically discrete population units has proven challenging, particularly for migratory birds. We used radio-telemetry to document winter site fidelity, movement patterns, and the spatial scale of demographic independence of Harlequin Ducks (*Histrionicus histrionicus*) in Prince William Sound, Alaska. During the winters of 1995–1996 through 1997–1998 and 2000–2001 through 2002–2003, 434 females were implanted with transmitters and their signals tracked from aircraft. Using a spatially nested design, we determined that 75% of radioed females remained in the bay or coastline area (mean area \pm SE = 16.7 \pm 1.5 km²) where they were originally trapped, 94% remained on the same island or mainland region within Prince William Sound (127.5 \pm 39.1 km²), and fewer than 2% emigrated from the 4,500-km² study area as a whole. Estimates for population size, survival, and movement rates were incorporated into a demographic model, the results of which indicated immigrant females accounted

for only 4% of the total adult female population at a scale of approximately 100 km². We conclude that wintering Harlequin Duck populations are demographically structured at relatively small scales, which has important implications for the scale of conservation action for the species.

CONSERVATION ASSESSMENT OF BREEDING WESTERN AND CLARK'S GREBES IN NORTHERN CALIFORNIA

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Although the population status of *Aechmophorus* grebe species is uncertain, there is evidence of a declining trend. I conducted an assessment of the status and conservation needs of breeding *Aechmophorus* grebes at a number of important sites in California in 2003. At these sites, nesting grebes face a number of issues that reduce their productivity, including disturbance at breeding colonies, problems with boat wakes and wind, poor habitat conditions, and water-level changes. Issues to address vary by location but generally include the need to post nesting-colony sites as closed areas to prevent disturbance during the nesting season, maintain stable water levels as much as possible, provide outreach to the public about grebes, post no-wake zones (and in some cases, install wave barriers to protect nests from waves), restore nesting habitat where possible, and monitor the results of implemented management actions. I recommend a regional approach to grebe conservation, including coordinated monitoring and decision-making processes.

INFLUENCES ON SURVIVAL OF GREATER SANDHILL CRANE NESTS AT MALHEUR NATIONAL WILDLIFE REFUGE, HARNEY COUNTY, OREGON

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Malheur National Wildlife Refuge is among the most important breeding sites for Greater Sandhill Cranes (*Grus canadensis tabida*) in the western US. We collected a large sample of data from crane nests here from 1990–1998 and used logistic regression to evaluate the effects of land use, predator abundance, weather factors, nest-site habitat, nest initiation timing, and intra-specific interactions (pair-density) on Greater Sandhill Crane nest survival. The results of our study identify important factors to consider in the management of wildlife areas to enhance productivity of Sandhill Cranes.

ASSESSMENT OF SANDHILL CRANE ECOLOGY IN THE SACRAMENTO-SAN JOAQUIN DELTA, CALIFORNIA, 2002–2003

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A study of wintering Sandhill Crane (*Grus canadensis*) ecology was conducted in 2002–2003 in the Sacramento–San Joaquin Delta, with Staten Island (Staten) being the focus, and was conducted to address the problem of defining conservation needs for cranes, including the state-threatened Greater subspecies (*G. c. tabida*). Staten supported approximately 15% of the Greater's population, and 36% of all crane foraging use in the Delta through the entire winter. Use of crops shifted in response to availability, with high preference for wheat, while corn was the most important crop through the entire winter. Winter home ranges of Greaters averaged less than one square mile. Flight distances from roost sites to foraging areas also averaged less than one mile. In contrast, Lesser Sandhill Cranes (*G. c. canadensis*) had much larger winter ranges and foraged farther from roost sites. Traditional crane wintering areas such as the Delta are vital to the welfare of cranes. Staten has increased in importance, while habitat loss continues to occur at other sites. Further decline of crane habitat could result in population-level effects, and, because relevant findings in our study indicate small winter home ranges and strong site fidelity, very local habitat mitigation would be necessary to minimize these impacts.

IT'S THE FAT! [Poster]

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Birds vary their mass during breeding to optimise the cost of transport and in response to energy reserve needs for incubation and other activities. Most energy reserves consist of lipids. Though it has been widely

assumed that mass changes in marine birds during breeding reflect changes in fat reserves, this relationship has rarely been demonstrated. Thick-billed Murres show a characteristic pattern of within season changes in body mass. To determine the role of lipid dynamics in these body-mass changes, we measured the size of fat reserves and its distribution in a sample of breeding murres ($n = 42$) from Prince Leopold Island, Nunavut, Canada. Total body lipid increased significantly between just after egg lay and late incubation ($F = 5.698$, $df = 1, 26$, $n = 27$, $P = 0.025$), and there was a non-significant decrease between late incubation and chick-rearing ($F = 3.124$, $df = 1, 25$, $n = 27$, $P = 0.08$). In the Thick-billed Murre, most fat reserves are carried subcutaneously (average 53% of body lipid). Skin mass was the best predictor of total body lipid of all wet mass of tissues tested ($R^2 = 0.67$, $n = 39$, $P = 0.001$). Skin fat is a highly accurate predictor of total body lipid ($R^2 = 0.92$, $n = 39$, $P < 0.0001$). As there were no significant differences in fat-free carcass mass ($F = 0.785$, $df = 2, 37$, $n = 40$, $P = 0.463$), our results confirm that most mass variation can be accounted for by variation in lipid reserves.

WHEN YOUR PARENTS ARE A DRAG: INCREASING THE COST OF DIVING IN THICK-BILLED MURRES

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I present the results of an experimental increase in the cost of diving in Thick-billed Murres rearing chicks. Males and females were manipulated ($N = 16$, 10 female/6 male) and compared with unmanipulated controls ($N = 16$, 8 female/8 male). The offspring were weighed and measured on days 1, 6, and 12 of the experiment. Plasma was collected from adults on the same days and later analysed for lipid concentration. I found that manipulated males had lighter chicks than manipulated females or controls (ANCOVA; $F = 23.036$, $df = 1, 8$, $n = 11$, $P = 0.001$). Manipulated males also had significantly higher neutral lipid concentrations in their plasma on day 6 of the experiment ($F = 10.52$, $df = 2, 15$, $n = 18$, $P = 0.001$); they returned to baseline levels by day 12. Lower masses in chicks may influence their ability to survive the long migration to Newfoundland. The increase in plasma lipids may be a symptom of increased energy mobilisation. These results are discussed in terms of changing prey availability with early ice breakup and their effects on nestling survival.

DISTRIBUTION AND ABUNDANCE OF MARINE BIRDS, MAMMALS, AND ZOOPLANKTON IN THE GULF OF THE FARALLONES AND CORDELL BANK

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We examined the hypothesis that the distribution and abundance of marine birds, mammals, and zooplankton in the Gulf of the Farallones and Cordell Bank is determined by bathymetric and hydrographic features and is predictable in space and time. Research cruises were conducted in May, July, September, and October 2004. We determined the distribution and abundance of birds and mammals during upwelling and non-upwelling events using standardized strip- and line-transects, zooplankton using hydroacoustics and nets, and the physical oceanography using CTD casts and the underway data acquisition system of the ship. The most noticeable hydrographic feature used by marine birds was the upwelling plume off Point Reyes. Cassin's Auklets (*Ptychoramphus aleuticus*) foraged in large numbers in the vicinity of the front during strong upwelling conditions and elsewhere during relaxation periods. Common Murres (*Uria aalge*) foraged over "green" waters south of Point Reyes and San Francisco Bay during both strong and weak upwelling episodes. Bathymetric features used by marine birds included shallow areas around the Farallones Archipelago, where Pigeon Guillemots (*Cepphus columba*) and Brandt's Cormorants (*Phalacrocorax penicillatus*) aggregated in large numbers. Among marine mammals, gray whales (*Eschrichtius robustus*) were found using shallow waters near the Southeast Farallon Islands, while humpback (*Megaptera novaeangliae*) and blue (*Balaenoptera musculus*) whales were generally sighted near the shelf break and east of Cordell Bank. A thorough knowledge of foraging areas used by marine predators in the Gulf of the Farallones and Cordell Bank is important because it will provide the scientific basis necessary for the design of a potential marine protected area.

IS THERE A BIMODAL FORAGING PATTERN FOR LITTLE GULLS IN NORTH AMERICA?

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The Little Gull (*Larus minutus*) is one of the most poorly known colonial waterbirds in North America. Our recent work to rediscover the nesting grounds in the subarctic, outline the migratory patterns through the lower Great Lakes, and estimate the North American population has led to several research questions. One of the most pressing biological issues is that almost nothing is known about the foraging ecology of this rare larid in the Western Hemisphere. This paper presents a test of the bimodal-foraging hypothesis. We conducted behavioral observations of over 25% of the estimated population in locations from the subarctic (summer) to the Niagara River (overwintering), and from Lake Ontario (spring migration) to Lake Erie (fall migration). The data suggest that Little Gulls shift foraging strategies, from piscivorous in the winter to insectivorous in the summer and during migration; that the timing and principal route of spring migration correlate with the emergence of mayflies, *Ephemera* spp., a species that also becomes a principal prey item in the subarctic; and that foraging patterns, as well as prey shifts, are mechanisms to avoid harassment and competition from its principal sympatric congener, Bonaparte's Gull (*Larus philadelphia*). To our knowledge, this is the first study to examine Little Gull foraging patterns in North America.

SEASONAL CHANGES IN FOOD HABITS OF SEABIRDS IN THE NORTH WATER POLYNIA: A MULTIPLE-INDICATOR APPROACH USING DIETARY, STABLE-ISOTOPE, AND FATTY-ACID ANALYSES

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Each year, millions of seabirds migrate to the North Water Polynya in Northern Baffin Bay to feed in its productive waters during the six months the polynya is free of ice. This study evaluates seasonal shifts in diets of Dovekies (*Alle alle*), Thick-billed Murres (*Uria lomvia*), and Black-legged Kittiwakes (*Rissa tridactyla*). Assessment of diets was done through a combination of stable-isotope analysis of muscle and liver tissue, fatty-acid analysis of subcutaneous fat, and stomach-content analysis. Dovekies had the lowest $\delta^{15}\text{N}$ values and, hence, the lowest trophic level in spring and summer, corresponding to their consumption of herbivorous copepods. In fall, their $\delta^{15}\text{N}$ values dramatically increased as they switched to feeding on carnivorous amphipods and fish. Throughout the study period, kittiwakes and murres had diets and stable-isotope values similar to fall Dovekies. Fatty acids from Black-legged Kittiwakes feeding in fall were distinct, likely due to their reliance on the pteropod *Limacina limacina*. Our study highlights the utility of using simultaneously conventional diet, stable-isotope, and fatty-acid analyses to infer dietary patterns.

AT-SEA DISTRIBUTION OF XANTUS'S MURRELETS AROUND SANTA BARBARA ISLAND, 1975–1977 [Poster]

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At-sea surveys for Xantus's Murrelets (*Synthliboramphus hypoleucus*) were conducted in the waters surrounding Santa Barbara Island, Channel Islands, during 1975–1977. In 1975, non-standardized surveys were conducted during April–July. In 1976 and 1977, seven radial transects out to 18.5 km from the island were surveyed regularly from January through July. Xantus's Murrelets were counted within 150 m of the ship. Peak Xantus's Murrelet densities were observed in 1976 and 1977 from March to May, during peak nesting activity. Xantus's Murrelets were found most often in the western, more oceanic waters adjacent to the island. Xantus's Murrelets were never seen within 0.5 km of shore. During the breeding season, they were most common within 6.5 km from shore (1975 and 1976) and between 2.5 and 8.5 km (1976). In late May, birds moved farther

offshore (10.5–12.5 km). Of the 3,741 Xantus's Murrelets seen, more than 80% were found in pairs. Solitary birds were seen regularly but in low numbers; large groups were never seen. This work represents the first examination of the foraging patterns of Xantus's Murrelets. It is our hope that these data will serve as useful baseline information for future studies and those that have occurred since 1977.

DISTRIBUTION AND ABUNDANCE OF XANTUS'S MURRELETS IN THE PACIFIC OCEAN

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We collated ship-board and aerial surveys from 1975 to 2003 to study the at-sea distribution and abundance of Xantus's Murrelets (*Synthliboramphus hypoleucus*) throughout their range in waters within 500 km of shore. We recorded 1,628 murrelets within 300-m strip-transects. Densities were highest over the continental slope. During the breeding season (March–June), murrelets concentrated in the Southern California Bight (SCB), with lower densities off northern Baja California and south-central California. During the nonbreeding period, densities were highest from central Baja California to central Oregon. We used generalized additive models to estimate abundance. A total of 39,700 birds was estimated for the nonbreeding season, consisting of 17,900 breeding birds (95% CIs = 13,900–21,000) and 21,800 subadults/nonbreeders. Examination of abundance across years (1975–2001 in SCB; 1985–2003 in central California) revealed no trends.

RESTORING SEABIRD HABITAT IN MÉXICO

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Over a period of 10 years, Island Conservation and Conservación de Islas have removed non-native mammals from 25 islands in northwest México and, in the process, have protected 188 populations of seabirds comprising 31 species. These actions, among other factors, have enabled increases in breeding seabirds; however, human disturbance continues to limit recovery potential. Asuncion and San Roque, two islands on the Pacific coast of Baja California, provide a good example. Formerly important seabird colonies, these islands had six seabird species extirpations and population reductions in at least three of the remaining four breeding species. In 1994, cats (Asuncion) and rats (San Roque) were eradicated, and a program to reduce human disturbance was initiated. Social attraction programs for Cassin's Auklets were deployed in December 1996 and have run intermittently since then. In January 2004, we saw the first evidence of auklet nesting in 30 years. Brandt's Cormorant numbers increased dramatically to several thousand birds by 2000. However, recurrence of human disturbance caused these birds to abandon in 2001. Given these observations, we feel the proposed Baja California Pacific Islands Biosphere Reserve is the best method to maintain the islands free of non-native mammals and reduce human disturbance so that these seabird resources can fully recover.

CONSERVATION OF THE XANTUS'S MURRELET IN MÉXICO

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The Xantus's Murrelet is endemic to Pacific Islands of southern California and northern Baja California. The murrelet's small global population, various threats at sea, plus vulnerability at nesting sites, led to its listing as threatened in México in 2000 and in California in 2004. Most murrelet island nesting habitat in the US and

México is federally protected; however, unlike in the US, habitat in México receives little or no active management. Nevertheless, large conservation gains have been made in México with the eradication of predators from 6 of 13 known breeding islands and 3 of 4 historical/likely breeding islands and the removal of herbivores from 6 known breeding locations and 2 historical/likely breeding islands. Despite these gains, ongoing threats of non-native mammal introductions to murrelet islands and threats from disturbance and habitat destruction are greater in México than the US. The building of a liquid natural gas terminal at Los Coronado Islands, the world's largest breeding colony of *S. h. scrippsi*, may cause the ongoing loss of large numbers of murrelets, due mostly to light pollution and disturbance. NGOs, primarily Conservación de Islas, play a key role in managing murrelet habitat in México; by promoting federal Biosphere Reserve status for all Xantus's Murrelet breeding islands, they will help establish long-term protection for this species.

MIGRATION PATTERN AND WINTERING RANGE OF COMMON LOONS: PRELIMINARY FINDINGS [Poster]

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The Common Loon, *Gavia immer*, breeds throughout the northeastern United States. Several surveys have assessed the abundance and distribution of summering loons. However, timing, migration patterns, and wintering range have not been adequately documented. During the summer of 2003, four Common Loons (three adults and one juvenile) from NY, NH, and ME were implanted with satellite transmitters. The transmitters were manufactured utilizing three different duty cycles corresponding to breeding, migration, and wintering periods. Data were received for each transmitter within 24 hours of data acquisition. From late August 2003 to mid-March 2004, we obtained 787 high-quality locations (Argos Location Class 1–3), accurate to <1,000 m, from a total of 1,990 location determinations (40%). The initiation date of migration, number of stopover locations utilized, and total migration-days recorded during fall migration differed significantly between the adult loons and the juvenile bird. The adult birds wintered along the Atlantic coast of Maine and southern New Jersey, while the juvenile bird utilized Long Island Sound. During the 2004 field season, eight additional loons were implanted and are currently being monitoring.

USE OF VANISHING BEARINGS AS A METHOD FOR LOCATING WADING BIRD COLONIES [Poster]

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Estimating the size of breeding populations of colonial nesting wading birds is a priority for waterbird management, but locating colonies is not always easy. Existing methodologies to locate wading-bird colonies require use of airplanes and/or systematic search of likely colony locations on the landscape. This study describes the use of vanishing bearings of Great Blue Herons (*Ardea herodias*) from estuarine foraging sites to determine the number and location of associated colonies. In 2002 (2003), frequency analysis of the vanishing bearings identified 23 (29) modes at 10 (15) sites. Of these modes, about one-half (12 [2002] and 15 [2003]) were associated with known colonies. Searches in 2002 and 2003 confirmed the existence of three colonies whose location was predicted by a consistent use of a vanishing bearing but went unnoticed during routine colony inventories using information provided by the public. An intensive search at a single foraging site in 2004 revealed two previously unknown colonies. These results suggest that following birds from the foraging sites is a viable method for locating colonies.

WHY SEABIRD COLONIES FORM RELUCTANTLY BUT GROW RAPIDLY

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Observations from the few empirical and theoretical studies that have addressed patterns of formation and growth of seabird colonies are paradoxical: prospective breeders are highly attracted to newly-formed colonies, yet they will compete for nest sites within established colonies and face the prospect of deferred breeding, rather than pioneer unoccupied habitat and form a new colony. The "information barrier" hypothesis of Forbes and Kiaser explains the attraction of established colonies by suggesting that conspecifics represent a valuable information resource concerning habitat suitability that mitigates costs of joining a colony. We investigated the formation and growth of Black-legged Kittiwake (*Rissa tridactyla*) colonies using productivity and population data from 14 colonies that formed during the late 1980s within Chiniak Bay, on Kodiak Island, Alaska. New colonies formed during a period of poor productivity and population declines within established colonies. They exhibited greater productivity than established colonies and displayed extremely rapid growth fueled by mass immigration for at least a decade. We propose that the information advantage is just one of many factors that contribute to the "Allee effect" (inverse density dependence) in young seabird colonies. We further suggest that timing of formation and rapid growth observed for new colonies in Chiniak Bay is best explained by merging Fretwell's classic "ideal despotic" and "Allee" habitat suitability models.

DIET OF AMERICAN WHITE PELICANS WINTERING IN LOUISIANA AND MISSISSIPPI

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The number of American White Pelicans (*Pelecanus erythrorhynchos*) wintering in the aquaculture production areas of the southeastern United States has increased dramatically. No published studies have reported on the diet of American White Pelicans wintering in this area. We collected 198 pelicans from loafing sites during winter and spring (1998–1999) at four locations in Mississippi and four in Louisiana. Mississippi collection sites were near aquaculture facilities (AQMS), and the Mississippi River and an oxbow lake adjacent to the river (RVMS). Louisiana collection sites were near aquaculture facilities (AQLA) and marsh habitat of coastal Louisiana (COLA). We identified, measured, and weighed all prey items found in pelican digestive tracts. Teleost otoliths were retained for fish prey identification to help determine species composition. Otoliths were identified to family and genus, when possible. The percent of otoliths by family group from stomachs of pelicans (N = 134) collected near (1) AQMS was 87.6% catfish, 8.5% shad, 4.0% other; (2) RVMS was 29.7% catfish, 58.6% shad, 6.3% sunfish, 5.4% other; (3) AQLA was 0.5% catfish, 63.3% shad, 27.6% sunfish, 8.3% other; (4) COLA was 7.4% shad, 12.8% sunfish, 19.8% mullet, 13.9% other, and 46.1% unknown. We found that American White Pelicans in Louisiana and Mississippi feed on native and aquaculture species typically occurring near their loafing sites.

NEW INSIGHTS INTO THE MOLT MIGRATION OF FEMALE KING EIDERS FROM STABLE CARBON- AND NITROGEN-ISOTOPE ANALYSES

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Female King Eiders are expected to demonstrate diverse patterns of wing molt relative to males because timing and location of molt are closely linked to breeding. We examined the stable carbon and nitrogen isotope values of primary feathers from female King Eiders during breeding on Alaska's North Slope and spring and molt migrations at Pt. Barrow, Alaska, in 2003. Additionally, we collected primary feathers from females implanted with satellite transmitters in 2003 and 2004. We found heavy stable carbon and nitrogen isotope values of primary feathers from 94% of the females, demonstrating that protein sources were derived from mixed aquatic and marine systems. However, 6% of females had significantly lower nitrogen-isotope values from feathers ($n = 96$, $P < 0.0001$) that coincided with the lightest stable carbon-isotope values in the carbon isotope range and were thought to indicate terrestrial molt in this group. We found no relationship between known geographic location of wing molt and stable isotope values of feathers from transmitted females. We concluded that we can infer relative proportions of female King Eiders molting in isotopically distinct regions

(e.g., marine vs. freshwater) from stable carbon and nitrogen isotope analyses. Evidence for terrestrial molt in female King Eiders was previously unsubstantiated.

RESTORATION OF REGIONAL TERN POPULATIONS: A MODEL FROM THE GULF OF MAINE

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Populations of Common, Arctic, and Roseate terns in the Gulf of Maine were in decline during much of the 20th Century and reached historic lows by 1977. Prior to 1984, few sites were actively managed for terns. The restoration of one historic tern colony at Eastern Egg Rock proved that the combination of predator and vegetation management and social attraction was an effective method for establishing new colonies. However, the benefits of restoring a single colony proved to be limited over time due to the potential for catastrophic events, especially predation by Herring and Great Black-backed gulls, Great-Horned Owls, Black-crowned Night-Herons, and mink that occasionally impact nesting success. In 1984, seabird biologists from throughout the Gulf of Maine adopted multiple-site management as the preferred method for attaining regional population growth. Since 1984, ten historic tern colonies have been restored, and four additional sites are actively managed for terns. In 2004, although Common, Arctic, and Roseate terns nested at a minimum of 47 sites, 98% of Arctic Terns, 88% of Common Terns, and 93% of Roseate Terns nested at managed sites. Despite continued predator problems, tern numbers remain stable or continue to increase within the region, as terns can move to alternate sites to avoid predation. This twenty-year-old program demonstrates the benefits of a regional approach to tern management.

SUPERNORMAL CLUTCHES (SNCs) IN RELATION TO INTRA-SPECIFIC NEST PARASITISM IN BLACK-TAILED GULLS

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A supernormal clutch (SNC) refers to a nest with an unusually large clutch. This term has been applied mostly to seabirds that typically lay three-egg clutches. We examined Black-tailed Gull (*Larus crassirostris*) nests with abnormally large numbers of eggs during the 1997 and 2000–2002 breeding seasons at Hong-do Island, South Korea. SNCs were found in 20 (2.49%) of 802 nests examined during 3 breeding seasons: 3 in 1997, 3 in 2000, and 14 in 2002 at Hong-do Island. Many studies suggest that occurrence of SNCs usually results from female pairings or polygynous associations in Laridae. However, female–female pairing and polygynous associations were not observed in Black-tailed Gulls nesting at Hong-do Island. We suggest that adults rolled dropped strange eggs into their nests. The dropped strange eggs may be parasitized ones. If host gulls find eggs laid by other gulls near the nest, they are likely to roll it into their nests. SNCs observed in Black-tailed Gull nests appeared to be a type of intra-specific nest parasitism. We compared the reproductive success of parasitized with non-parasitized clutches. In addition, we compared detected parasitic with non-parasitic eggs within a clutch. Hatching efficiency of parasite eggs was lower than that of host eggs in a parasitized nest. Fledging success and hatching success was highest in c/2; c/4 and c/5 had the lowest success. Results imply that productivity of parasitized nests were lower than success of non-parasitized nests. If parasitic nests increase, the breeding population may decrease.

EFFECT OF DATE OF BREEDING ON BREEDING SUCCESS IN BLACK-TAILED GULLS: MEANING OF ARRIVAL BEHAVIOUR (COLONIAL MOBBING) [Poster]

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In this study, we investigated the nest timing and breeding success of Black-tailed Gulls (*Larus crassirostris*) in relation to initial arrival behaviour (colonial mobbing) after early return on their breeding ground. Investigations of initial arrival behaviour of Black-tailed Gulls were carried out from 7 April to 13 April in 2003. Black-tailed Gulls that arrived at the breeding ground did not remain on their territory. Instead, they fed to accumulate energy for breeding. As the egg-laying period approached, they gradually increased time spent on the territory. During the breeding season, time spent at the nest was highest on 22 April, when adults

remained on the territory all day. Breeding activity was also highest at this time. Black-tailed Gulls appear to supplement energy rather than keep the territory before breeding starts.

CHANGES IN DISTRIBUTION AND ABUNDANCE OF WHITE-WINGED AND SURF SCOTERS ASSOCIATED WITH THE INVASION OF THE VARNISH CLAM

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Prey distribution and density are known to influence habitat choice by sea ducks. We considered the role of an invasive species, the varnish clam *Nuttallia obscurata*, in altering scoter distribution and density in Baynes Sound, British Columbia. The varnish clam was first introduced in the Strait of Georgia in the early 1990s and quickly became abundant in soft-bottom intertidal environments. In Baynes Sound, we found that varnish clams constituted a large proportion of clams in the environment, as well as in the diets of scoters. We compared bird survey data from before the varnish clam invasion (1980–1981) with matched data collected post-invasion (2002–2004) and found that scoter numbers nearly doubled. Furthermore, the greatest increases were detected in portions of Baynes Sound with the highest abundance of varnish clams. Finally, we analyzed the contemporary relationships between the density and distribution of both scoter species and those of varnish clams and other prey species. Although we recognize that our findings are strictly correlational, they strongly suggest that scoters have responded distributionally to this newly available prey resource.

A COMPREHENSIVE CONSERVATION STRATEGY FOR SEABIRDS IN THE CALIFORNIA CURRENT SYSTEM [Poster]

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The North American Waterbird Conservation Plan was developed to provide a continental perspective on the status and conservation needs for waterbirds and their habitats in North America. Acknowledging that on-the-ground conservation happens at a more local scale, the continental plan recommends that its priorities be stepped down in local and regional plans organized around Bird Conservation Regions (BCRs). In the California Current BCR, partners have completed assessments and agency-focused plans that provide the foundation for a comprehensive waterbird conservation strategy for this marine ecosystem. Two newly released conservation plans deliver a wealth of information and science-based recommendations: the USFWS Pacific Region Seabird Conservation Plan, developed by the U.S. Fish and Wildlife Service, and the California Current Marine Bird Conservation Plan, developed by PRBO Conservation Science. The partners propose to synthesize these and other documents into a strategy which will better guide and support the work of all regional stakeholders. The synthesized strategy will specifically identify priority species, areas, and issues; short- and long-term measurable goals; and provide recommended actions to achieve those goals. Moreover, it will also facilitate integration among conservation strategies already developed for other groups of birds in the region, as called for by the North American Bird Conservation Initiative.

BREEDING AND ROOSTING DYNAMICS IN A POPULATION OF BRANDT'S CORMORANTS AT VANDENBERG AIR FORCE BASE, CALIFORNIA

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Seabird colonies at Vandenberg Air Force Base (VAFB) are part of an oceanographically variable ecosystem just north of Point Conception, where cold waters of the California Current meet warm waters of the Southern California Bight. Brandt's Cormorants (*Phalacrocorax penicillatus*) were first observed breeding at VAFB in 1995. We have monitored this mainland breeding colony since 1999 and have collected year-round roosting data since 2001. Although regression analysis identified significant fluctuations in the breeding population since 1999, the overall trend is one of increase. Breeding success followed no determinable pattern and could not directly explain observed fluctuations in the breeding population. However, we observed

significant exponential growth in breeding-season roosting numbers from 2001–2004. It is known that Brandt's Cormorants generally return to their natal colony to breed. However, birds typically do not breed until 3 to 4 years of age, and breeding may be postponed if local prey availability is poor. Thus, assessing only the number of nesting birds may not be optimal for monitoring short-term population growth. We suggest monitoring roosting birds during the breeding season as a more reliable metric for examining population dynamics.

USING DIGISCOPING TO COLLECT PHOTOGRAPHIC VOUCHERS OF FISH IN SEABIRD DIET STUDIES

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While conducting a diet study of Caspian Terns (*Sterna caspia*) in the San Francisco Bay, we used digiscoping to collect digital photographic vouchers of fish. Observer based diet studies pose several problems: (1) newly trained observers may not correctly identify as many fish at the beginning of the study as they will once experienced; (2) observers tend to count fish they know and ignore unknowns; and (3) unless fish are directly recovered from birds, there are no independent vouchers to confirm identification. Fish recovery frequently requires lethal collection, colony disturbances, and or limits to sample size. By holding a high-resolution point-and-shoot Canon PowerShot S45 digital camera to the eyepieces of spotting scopes and binoculars, we were able to take quality photographic vouchers of fish as terns brought them into the colony. Fisheries biologists independently identified the vouchers. During the study, we made 16,423 observations, identifying 92% of the fish either at the family or genus level (18%) or to the species level (74%). We supported these observations with over 2,500 digital photographs. Vouchers confirmed field identification of all species and allowed for identification of several species unidentifiable in the field. Digiscoping has expanded our understanding of diet of Caspian Terns in San Francisco Bay and, more importantly, provides a technique that can be widely used among those studying species that transport prey in the bill.

BEHAVIOURALLY MEDIATED INDIRECT INTERACTIONS BETWEEN HARLEQUIN DUCKS AND RAINBOW TROUT: AN EXPERIMENTAL APPROACH [Poster]

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Harlequin Ducks (*Histrionicus histrionicus*) in British Columbia have shown low productivity, based on age ratios in winter aggregations. We conducted studies on breeding streams to consider whether poor recruitment could be related to food limitation. Food availability for Harlequin Ducks could be limited by either a reduction in overall density of suitable prey or limited access to prey because of anti-predator behaviours exhibited in response to the presence of fish in the breeding streams, which can be termed a Behaviourally Mediated Indirect Interaction (BMII). We conducted field experiments to test for the presence of BMII between Harlequin Ducks and Rainbow Trout (*Oncorhynchus mykiss*). These experiments utilised a controlled environment to determine if aquatic insects in the family Ephemerellidae changed their diel location on rocks in response to different predator odours. Unlike similar studies with other aquatic insects, we found that Ephemerellids do not exhibit differing diel location behaviours in the presence or absence of the different predator odours, although they did show clear shifts in location between day and night. Our data do not support the presence of a BMII between Harlequin Ducks and Rainbow Trout for this family of insects, although other families may respond differently.

HABITAT QUALITY, HUMAN DISTURBANCE, AND THE DISTRIBUTION AND ABUNDANCE OF WINTERING PIPING PLOVERS

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Despite almost two decades of intense conservation programs, threats to Piping Plovers remain substantial throughout their annual cycle. Piping Plovers are gradually losing significant portions of their

historic wintering habitat to land conversion and degradation, recreational activities, inlet and shoreline stabilization, dredging of inlets, beach maintenance, and pollution. To understand the impact of these threats on non-breeding plovers, we synthesized and investigated the relationship among habitat quality, human disturbance, and the distribution and abundance of wintering Piping Plovers. Digital Orthographic Quadrangles (DOQs) of 32 Gulf of México sites with known plover usage were analyzed for habitat characteristics (e.g., intertidal and beach area) and proxies of human disturbance (e.g., urban area, roads, beach access points). Preliminary analyses suggest a positive correlation between PIPL abundance and intertidal area; furthermore, results indicate a negative correlation between PIPL density and the proxies of disturbance. As individual components, the variables fail to elucidate fully plover wintering distribution; however, in combination, they provide more explanatory power. This study provides critical insights into the impact of disturbance and habitat alteration on wintering plovers.

IDEAL FREE DISTRIBUTION IN BLACK-TAILED GULLS ON HONGDO ISLAND, KOREA? [Poster]

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These experiments examined habitat selection by Black-tailed Gulls (*Larus crassirostris*) at Hongdo Island during 2002 and 2003. We compared breeding performance in four nesting habitat identified: “rocky habitats” vs “grassy habitats.” Breeding performance (clutch size, egg size, fresh egg mass, weight of chicks and growth rate) in lower parts and rocky habitats were larger than those in higher parts and grassy habitats, and laying and hatching dates in lower part and rocky were faster. However, breeding success of gulls between habitats was similar. Egg and chick mortality were not significantly different between habitats. Nest-spacing in rocky habitats was closer than in grassy habitats; thus, the preferred habitat on Hongdo Island was rocky. Although breeding parameters (clutch size, laying date, hatching date, chick weight, and growth rate) and density in rocky habitats were higher, reproductive success did not differ significantly between rocky and grassy habitats. Therefore, we conclude that the population of Black-tailed Gulls on Hongdo Island may conform to an ideal free distribution.

WHY DON'T BLACK-TAILED GULLS SELECT ANY PLACES? ESTIMATING REPRODUCTIVE SUCCESS USING ARTIFICIAL NEURAL NETWORKS

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For the conservation of Black-tailed Gulls (*Larus crassirostris*), nest-site selection of Black-tailed Gulls on Hongdo Island, Korea, was studied during the breeding season of 2002 and 2003. Our research (1) compared biological and environmental data between nest-sites and random points and (2) estimated reproductive success at random points using Artificial Neural Network Models. Six characteristics were measured: vegetation cover (%), vegetation height (cm), rock cover (%), nest wall (%), nearest distance between neighbor (cm), and slope (°). The characteristics at nests were compared with at random points. The characteristics at nest-sites were higher than at random points. However we did not know why the gulls did not select random points. We indirectly analyzed the advantage of nest-site characteristics for comparing between nest-sites and random points. Thus, we estimated breeding success at random points using artificial neural network, Back-propagation network (BPN, Multi-layer feed-forward neural network). BPN allows prediction of output data (e.g., breeding success) for a given input data (e.g., environment variables). When breeding success was trained with the BPN, convergence was usually reached by the 10,000th iteration. The training sets were well in accord with the matching output. To verify the predictability of the trained network, we further provided new breeding success in random points. Our model showed a high learning rate. Observations were significantly related to estimate results (Pearson correlation $r = 0.72$, $P < 0.001$). In this result, we predicted that breeding success in random point (non-selected nests) was low. Therefore, we conclude that Black-tailed Gulls on Hongdo Island prepared nest-sites with high rates of covering and many nest-walls. The results provided ecological information to conserve breeding habitats. This study additionally demonstrated that artificial neural networks could be useful for analyzing data for breeding behavior and ecology.

CLAM PREDATION AND FORAGING BEHAVIORS OF SURF AND WHITE-WINGED SCOTERS

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Predation is known to be an important process affecting the diversity and abundance of organisms within intertidal marine communities. Studies of intertidal predation by seaducks have documented strong top-down effects on mussel populations in rocky intertidal communities. However, the impact of these gregarious predators in soft-bottom communities remains largely unexplored. We are conducting a study in Baynes Sound, British Columbia, to determine the effects of predation by wintering Surf and White-winged scoters on the density and size-classes of their primary prey, intertidal clams. Between scoter arrival in the fall and departure in the spring, clam density decreased for Manila clams (*Venerupis philippinarum*) and varnish clams (*Nuttallia obscurata*), the main prey species of scoters in the study area. Decreases were most pronounced for Manila clams, especially within the size classes consumed by scoters. To determine if the observed clam density decreases were of a sufficient magnitude to influence scoter foraging effort, we monitored a range of scoter dive-behaviors. The proportion of time spent feeding and number of dives/hour increased throughout the winter, while foraging success rates (# of clams captured/dive) decreased. Our findings suggest that (1) scoters can have important effects on invertebrate communities in soft-bottom intertidal habitats, and (2) there is direct feedback from these effects, causing scoters to modify their overall foraging effort.

RESTORATION OF SEABIRDS IN THE SOUTHERN CALIFORNIA BIGHT INJURED BY MONTROSE DISCHARGES [Poster]

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From the late 1940s to the early 1970s, the Montrose Chemical Corporation discharged millions of pounds of DDTs and PCBs into the marine environment off Southern California. Negative effects of DDT contamination were observed throughout the Southern California Bight, including eggshell thinning and reproductive failure in various nesting seabirds. The Montrose Settlements Trustee Council (composed of the U.S. Fish and Wildlife Service, National Park Service, National Oceanic and Atmospheric Administration, California Department of Fish and Game, California Department of Parks and Recreation, and California State Lands Commission) seek to restore seabirds that were impacted from DDT contamination. A total of 19 seabird restoration projects have been considered to date that range from habitat improvement to social attraction. A step-wise process of evaluating these 19 seabird projects resulted in the selection of 8 projects to be carried forward for detailed evaluation in a draft Restoration Plan. This Restoration Plan will be available for public review in early 2005. Once the plan is approved, the Montrose Settlements Restoration Program will begin implementation of preferred seabird restoration projects.

GENETIC STRUCTURE AND STATUS OF JABIRU STORKS FROM THE BRAZILIAN PANTANAL [Poster]

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The Jabiru Stork (*Jabiru mycteria*) is the largest flying waterbird in the Western Hemisphere. The species occurs in Neotropical wetlands from southern México to northern Argentina and it is Appendix I listed by CITES. Here, we describe the current genetic status of Jabiru population in the Pantanal using seven microsatellite loci and the control region of mitochondrial DNA (mtDNA; 492 bp). Estimates of genetic variability in microsatellite loci (mean heterozygosity = 0.41, mean number of allele per locus = 3.29) and mtDNA sequences (haplotype diversity = 0.93, nucleotide diversity = 0.006) indicate moderate levels of genetic variability. No significant levels of genetic differentiation among three sampling points were observed in either markers (microsatellites F_{st} = 0.13, mtDNA F_{st} = -0.06). The unimodal pattern of the mismatch distribution and F_u 's F -test results, based on the mtDNA sequences, suggested a recent expansion of the Pantanal population. These indications of demographic expansion could explain the absence of genetic structuring observed. Our results obtained with nuclear and mitochondrial markers seem to indicate that there is limited genetic differentiation among Jabiru sampling points in the Pantanal. It may be appropriate to consider the

Pantanal area as a single management unit. Additional studies using mitochondrial DNA sequences will be conducted to assess the genetic variability and level of differentiation among populations of the Jabiru throughout its range.

THE PERUVIAN BOOBY: INDICATOR FOR CHANGES IN AN UPWELLING SYSTEM?

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The area of the Humboldt Current is characterised by high productivity that is undergoing severe changes over time due to effects by the El Niño–Southern Oscillation phenomenon. Consequently, resident seabirds have to cope with a high variability in food availability. We studied the foraging ecology of a piscivorous seabird, the Peruvian Booby *Sula variegata*, off the coast of north-central Chile, focusing on their behaviour at sea and the location of their feeding areas. Counts of seabirds at sea using the NW European standard methodology were combined with information from small data-loggers attached to individual birds. Main feeding grounds were located close to land in areas of frequent upwelling events. Data from several years revealed substantial variability in the foraging distribution and diet composition of Peruvian Boobies. These data and counts of birds in the breeding colony on Isla Pajaros suggest that the birds react strongly to climatic and hydrographic changes in the upwelling system of the Humboldt Current caused by the ENSO phenomenon. Further studies using remote-sensing technologies, in combination with at-sea counts, applications of data-loggers, and observations in the breeding colonies, would be helpful in understanding how the birds modify their behaviour in response to changes in food availability.

NESTING AND BREEDING CHRONOLOGY OF A SOUTH LOUISIANA HERON ROOKERY [Poster]

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To determine optimal survey periods for wading bird colonies, I observed the nesting and breeding chronology of egrets, herons, night-herons, and spoonbills at Lake Martin, a cypress/buttonbush swamp in south Louisiana. Weekly observations were conducted from 31 March 2004 through 24 July 2004. Ten random points, 40 m in width, were sampled along the perimeter of the colony. Sampling consisted of recording the number of birds of each species at each point and what stage the birds were actively participating in. Wading birds were categorized into specific chronological stages: arrival, incubation, hatchings, and fledglings. In addition, the vegetation in which nests were constructed was also recorded. Observations ceased when the majority of the fledglings had left the nests and began wading on their own. I observed that Great Egrets and night-herons initiated nesting in late March and early April. Shortly thereafter (mid-April), Roseate Spoonbills arrived and began nesting, while Little Blue Herons began their staging rituals. Cattle Egrets, Snowy Egrets, and Tricolored Herons also began to initiate nesting in late April. Approximately three weeks after each species arrived, eggs began to hatch. Hatching time varied because several individuals of all species began nesting very late into the summer; thus, eggs were hatching from late April to late July.

AVIAN PREDATION ON JUVENILE SALMONIDS IN THE COLUMBIA RIVER BASIN: DETERMINING PRIORITIES FOR INVESTIGATION AND POTENTIAL MANAGEMENT

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Piscivorous birds are often effective predators of juvenile salmonids (*Oncorhynchus spp.*) in the Columbia River Basin, where 12 of 20 evolutionarily significant units of salmonids are listed under the US Endangered Species Act. Smolts can be particularly susceptible to avian predation at anthropogenic features (e.g., dams) or near nesting sites of colonial waterbirds. Beginning in 1997, we have evaluated avian predation throughout the basin to determine where impacts on survival of salmonids are greatest, then collected detailed data at these locations to allow managers to assess the appropriateness and potential efficacy of management. Impacts are consistently greatest in the Columbia River estuary, where the largest colonies of Double-crested

Cormorants (*Phalacrocorax auritus*) and Caspian Terns (*Sterna caspia*) in North America consume millions of smolts annually. Smaller interior colonies of waterbirds, such as the Crescent Island Caspian Tern colony in eastern Washington, may also take significant numbers of in-river migrating smolts, perhaps exceeding 20% of some in-river migrant groups in some years. Inland colonies of gulls (*Larus californicus* and *L. delawarensis*), while large, do not constitute a source of significant mortality to salmonids, nor does the sole American White Pelican (*Pelecanus erythrorhynchos*) colony in Washington, located on the mid-Columbia River. Actual impacts to salmonid populations due to avian predation remain difficult to estimate; however, simple deterministic population models suggest that, while managing avian predation would not recover salmonid populations, the benefits may approach those from other proposed recovery actions.

NORWAY RATS AS PREDATORS OF LEAST AUKLETS AT KISKA ISLAND, ALASKA: FURTHER EVIDENCE FROM STABLE-ISOTOPE ANALYSIS

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Extreme interannual variation in Least Auklet (*Aethia pusilla*) reproductive success at Sirius Point, Kiska Island, has been attributed to varying abundance of introduced Norway rats (*Rattus norvegicus*). To investigate this issue further, we used stable-isotope analysis to reconstruct the diet of Kiska Norway rats at the auklet colony at Sirius Point and at the "lake district," where auklets were absent. Significant correlations between liver and pectoral muscle isotope values for $\delta^{13}\text{C}$ ($r^2 = 0.11$, $P = 0.03$) and $\delta^{15}\text{N}$ ($r^2 = 0.12$, $P = 0.02$) indicated that individual dietary preferences remained nearly constant over the sampling period. MANOVA revealed a significant difference in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values between the auklet colony and the lake district (Wilks' $\Lambda = 0.16$, $P < 0.001$ for liver; and Wilks' $\Lambda = 0.03$, $P < 0.001$ for pectoral muscle), suggesting that rat diet differed between locations. Rats at the auklet colony showed a heavier $\delta^{15}\text{N}$ value (12.84 ± 0.25 liver; 12.81 ± 0.87 pectoral muscle at Sirius Point; 11.77 ± 1.40 liver; 11.68 ± 0.36 pectoral muscle at Christine Lake; and 6.50 ± 1.95 liver; 5.29 ± 1.14 pectoral muscle at East Kiska Lake) and a marine $\delta^{13}\text{C}$ signature, indicating that they were eating from a marine source and at a higher trophic level (i.e., auklets) than rats at the lakes.

EDGE EFFECTS ON NEST PREDATION IN MARBLED MURRELETS: AN EXPERIMENTAL APPROACH

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Concern for Marbled Murrelet populations due to ongoing harvest of old-growth habitat has led to detailed description of nesting preferences at the tree and stand level. However, it is unclear how landscape-level factors such as patch size influence productivity of nests. For instance, nests may be more vulnerable to predation in smaller patches, which contain a higher proportion of edge versus interior habitat. Higher nest predation rates at edges may occur if predators exhibit a behavioural preference for edges or if nests are more visible at edges. Thus, an apparent nesting preference for edges may no longer be adaptive if industrial fragmentation has reduced patch sizes and facilitated predator access at levels that are novel for murrelets. To test the potential implications of this hypothesis for management strategies, we compared predation rates of artificial eggs and nestlings placed on nesting platforms at forest-edge versus interior sites. We investigated whether the strength or direction of "edge effects" varied among recent clear-cut, regenerating stand, and riparian edges. Preliminary data show higher predation rates at habitat edges for artificial eggs irrespective of edge type but no difference in predation rates of nestlings between the edge and interior. We attribute these differences to the behaviour and distribution of nest-predator species and variance in habitat structure at forest edges.

ONTOGENY OF THE SEX RATIO IN NAZCA BOOBIES

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Sex-ratio (SR) theory is one of the more developed areas of evolutionary ecology; however, adaptive explanations for SR variation among vertebrates are still the subject of much debate. Our group has focused long-term reproductive and demographic studies on a population of Nazca Boobies (*Sula granti*) with a significantly male-biased adult sex ratio (ASR). This pelagic seabird breeds in a large colony at Punta Cevallos on the island of Española in Galápagos, Ecuador. Our group is striving to understand the causes and consequences of the observed male-biased ASR in this population. We have used PCR amplification of an intron region of the CHD gene to determine the sex of hatchlings and fledglings from several breeding seasons. Our results indicate that the secondary (hatching) and tertiary (fledging) SRs are 1:1. Multi-state mark-recapture modeling has shown that there is no long-term sex-specific cost of reproduction in adults that may contribute to the male sex bias. A multi-year evaluation of band recapture surveys assessing the recruitment (into the adult population) SR for 8 cohorts, has shown that this SR is significantly male biased. Therefore, the shift to the male bias must occur after the period of parental care ends in the subadult stage, between fledging and recruitment.

WADING BIRD BEHAVIOR IN MOIST-SOIL MANAGED WETLANDS IN EAST TEXAS

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Moist-soil management techniques generally emphasize waterfowl and shorebird use, but few data exist for wading bird behavior in moist-soil managed wetlands, as they are rarely management targets. We developed time-activity budgets for Great Egrets (*Ardea alba*), Snowy Egrets (*Egretta thula*), Cattle Egrets (*Bubulcus ibis*), Wood Storks (*Mycteria americana*), and White Ibises (*Eudocimus albus*) from April–Aug 2004 at the Richland Creek Wildlife Management Area in east Texas. We measured behavior using three-minute focal samples during three diurnal periods. Over 1,500 focal samples were collected during 2004. We used multivariate analysis of variance to examine differences among species, months, and time periods. Preliminary analyses demonstrated that behaviors did not vary among time periods (Wilks' $\lambda = 0.92$, $P = 0.19$) nor months (Wilks' $\lambda = 0.92$, $P = 0.15$), but did among species (Wilks' $\lambda = 0.52$, $P < 0.001$), where feeding, moving, resting, and standing varied. Wood Storks spent the most time resting (70%), whereas White Ibises spent the most time feeding (44%). The egrets spent the most time moving (21–30%) and standing (13–38%), and little time feeding (7–17%). Our results demonstrate that wading birds use moist-soil managed wetlands for several reasons and that future moist-soil management strategies should incorporate wading birds, where use, occupancy, and diversity are management goals.

LIFE HISTORY AND HUMAN-INDUCED CONSTRAINTS INFLUENCE CASPIAN TERN FORAGING BEHAVIOR

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Foraging habitat quality is a function of prey predictability, prey quality, prey availability, and proximity to breeding habitat. These factors may change as a function of system phenology and human activities. In the Mid-Columbia, there are two foraging areas for Caspian Terns: lakes surrounding the breeding colonies at the Potholes Reservoir and the Columbia River, 40 km away. Both foraging areas contain different fish communities. The River provides abundant and predictable prey in the spring, primarily out-migrating salmonids, otherwise, prey quality is low. Prey availability in the Reservoir is limited by water level; however, prey quality is high, and terns are in close proximity to foraging habitat. We hypothesize that terns will forage on salmon at the River before they are constrained by chick rearing, whereas, once chicks hatch, salmon outmigrate, and reservoir water levels decline, terns should switch to the closer food source. We examined our hypotheses through a combination of behavioral observations, gut-content analyses, bioenergetic modeling, and satellite tagging. Our results show that terns will choose the more distant foraging habitat at the river before

chick-rearing constraints occur. After chick hatching, terns utilize the river less, except in high water level years at the Reservoir, when fish availability is low. I will discuss how both constraints on foraging behavior affect salmon predation by terns.

MECHANISMS THAT SHAPE SEABIRD DISTRIBUTION IN TIME AND SPACE: HYDROGRAPHY AND SEABIRDS IN THE SOUTHEASTERN NORTH SEA

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Since 1990, seabird distribution in the southeastern North Sea has been recorded by German scientists following the internationally standardised seabirds at-sea method. Meanwhile, the general distribution patterns during the different seasons can be described for all common species. To reveal the mechanisms that shape and control these distribution patterns, a suite of studies that took place during the non-breeding season was analysed to investigate the relationships between seabird distribution and hydrography. For this purpose, we related the distribution of all common species in the southeastern North Sea to horizontal and vertical profiles of different hydrographic parameters. Analyses revealed that most of the common species showed a significant, or at least a positive, correlation to a selection of different hydrographic structures. On the larger scale, these hydrographic phenomena consisted of distinct water masses with differing salinity, temperature, and water transparency. At a smaller scale, frontal structures, which were created e.g., by local upwellings or river-plume fronts, were important. With the hydrographic situation in the southeastern North Sea being highly dynamic, we expect that seabird distribution patterns also underlie a high variability due to their link to hydrographic features. By analysing the exact nature of the relationship between seabird distribution and hydrography, it should be possible to evaluate seabird distribution patterns and predict their variability.

XANTUS'S MURRELET MONITORING PROGRAM AT SANTA BARBARA ISLAND, CALIFORNIA, 1983–2003

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From 1983 to 2003, Channel Islands National Park (with assistance from other groups) monitored samples of nests of Xantus's Murrelets (*Synthliboramphus hypoleucus*) at Santa Barbara Island, California, to examine nesting phenology, occupancy, egg fate, and site productivity. Nesting phenology varied widely between years, with egg-laying between February and July. Occupancy and annual productivity declined over the study period, consistent with population declines reported for this colony by other studies. Annual productivity ranged widely, from 0.39–1.21/nesting attempt. Although annual predation of eggs by deer mice (*Peromyscus maniculatus elusus*) ranged widely (0.0–68.9%), we found no relationships between variation in mouse density and levels of egg predation, hatching success, or site productivity. This monitoring program should be improved and continued annually, in conjunction with long-term studies of murrelets, mammalian and avian predators, prey resources, and other human impacts to assess and model population changes better at the largest colony in California.

FORAGING BEHAVIOR OF STREAKED SHEARWATER IN JAPAN

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Maximal dive depths of several species of offshore albatrosses and petrels have been reported recently. However, little is known about dive depth and daily foraging pattern of coastal feeding shearwaters. Streaked Shearwaters are endemic in eastern Asia and are believed to feed in coastal waters during the breeding period. We examined the diving behavior and diet of Streaked Shearwaters breeding on Mikura Island, southern Japan. Basing on time-depth data collected using small data-loggers, shearwaters dived less than 7 m deep during foraging trips of 1 to 13 days. Mean dive depth and duration were $1.5 \pm \text{SD } 0.9$ m and $4.6 \pm \text{SD } 1.2$ sec, respectively. Most dives occurred in the daytime. During long trips (>5 days), birds fed in cold waters (<22°C),

presumably off Hokkaido. But birds fed in warm waters (>24°C), presumably in surrounding waters off the colony. The meals delivered to chicks were composed of pelagic fishes such as Japanese anchovy and Pacific saury and squids.

RESTORATION EFFORTS FOR COMMON MURRES AT SAN PEDRO ROCK, CALIFORNIA, 1998-2004
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We used social attraction methods from 1998–2004 in an attempt to restore a breeding colony of Common Murres at San Pedro Rock (SPR), California. Murres bred here historically but were extirpated in the early 20th Century by commercial egg collectors and possibly other factors. Social attraction included murre decoys (adults, eggs, and chicks), cormorant decoys, audio of murre vocalizations, and mirrors. Although murres were observed on SPR each year, no breeding was documented. In most years, visits by prospecting murres peaked near the end of the breeding season at nearby colonies, and little or no attendance earlier. Highest counts occurred in 1998, when severe El Niño conditions resulted in nest abandonment at most nearby colonies. Results differed markedly from the Devil's Slide Rock (DSR) site only 2 km away, where breeding occurred the first year of social attraction efforts in 1996 and colony growth has continued. Differences at SPR included lack of recent murre breeding, nesting ravens, no nesting cormorants, and potential attraction of murres to the newly-reestablished DSR colony.

INCUBATION BEHAVIOR OF KING EIDERS ON THE NORTH SLOPE OF ALASKA

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The patterns and constancy of incubation are unknown in King Eiders (*Somateria spectabilis*). Incubating females face conflicting selection pressures: maintaining a favorable thermal environment for embryo development, maintaining a favorable energy balance for themselves, and minimizing the risk of predation on themselves and their eggs. King Eiders are near the extremes of the waterfowl continuum in severity of climate and reliance on nutrient reserves and, thus, are an interesting species in which to study incubation behavior. We placed artificial eggs containing HOBO data-loggers in nests at two sites on Alaska's North Slope, Teshekpuk and Kuparuk, from 2002–2004 ($n = 10/\text{site}/\text{year}$). We set data-loggers to record nest temperature every 2 minutes. Females showed very high incubation constancy at both Teshekpuk (0.946–0.978) and Kuparuk (0.987–0.992). We attempt to describe incubation behavior and relate the incubation constancy of individuals to environmental and nest-habitat characteristics. We test hypotheses regarding variation in incubation constancy and describe variation in incubation constancy in terms of recess frequency and recess length.

REPRODUCTIVE COSTS AND CONSEQUENCES OF MALE ATTENDANCE BEHAVIOUR AT COMMON EIDER COLONIES

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Typically male ducks follow females to breeding grounds, where males mate-guard through nest searching and egg-laying but do not follow females to nests. However, male Common Eiders (*Somateria mollissima*) attend females at nests during early stages of nesting, reminiscent of some seabird traits. The questions that arise are: (1) why does this occur?; and (2) what does the male gain by being on the colony? I tested whether male Common Eiders balance predation risk against possible reproductive benefits of attending females. I found that, among 83 eider colonies, males do not attend females under conditions when they or the nest are at greater risk of predation. This occurred most often on single-island colonies or islands within

archipelagos that had stunted or were free of vegetation. At a colony where males do attend females, they neither participated in nest site choice, nor did the duration of their attendance affect the number of eggs that hatched. We recommend that future studies focus on whether males attend to protect paternity.

FINDINGS FROM THE 5-YEAR STATUS REVIEW OF THE MARBLED MURRELET IN WASHINGTON, OREGON, AND CALIFORNIA

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In 2003, the U.S. Fish and Wildlife Service contracted with EDAW, Inc., and a panel of experts to conduct a review of the status of the Marbled Murrelet (*Brachyramphus marmoratus*) in California, Oregon, and Washington since listing under the U.S. Endangered Species Act in 1992. Data on breeding biology, population size, and terrestrial/marine habitat use are comprehensive, while the amount of occupied habitat, reproductive success, genetics, diet, and variation in prey resources are less well known. World population size was estimated at 947,500 birds, with 2% in the listed portion of the range. Available data on genetic and ecological differences indicate at least 3 primary populations: (1) Aleutian Islands; (2) Alaska Peninsula to Puget Sound; and (3) western Washington to California. Demographic modeling suggests that the population within the listed range will decline over the next 40 years, particularly in California. Population declines appear related to the effects of historic and ongoing loss of breeding habitat in old-growth forests, combined with poor reproductive success from relatively high levels of corvid nest predation in remaining forest patches. From the available information, long-term survival of the Marbled Murrelet in the listed range is not certain.

STAND-SCALE HABITAT ASSOCIATIONS ACROSS A LARGE GEOGRAPHIC REGION OF AN OLD-GROWTH SPECIALIST, THE MARBLED MURRELET

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We used two metrics, occupancy and relative abundance, to study forest-stand characteristics believed to be important to a threatened seabird that nests in old-growth forests, the Marbled Murrelet (*Brachyramphus marmoratus*). Occupancy refers to murrelet presence or absence based on observed bird behaviors, while relative abundance refers to categories of low, medium, and high number of bird observations/survey in a stand. Within the murrelet's nesting range in California and southern Oregon, we measured habitat and climatic variables in all old-growth stands surveyed for murrelets between 1991 and 1997. The two metrics produced similar results. In California, murrelets most often occupied or were abundant in redwood (*Sequoia sempervirens*) stands with large trees (>100 cm DBH) located on gentle, low-elevation slopes or on alluvial flats close to streams. In the less flood-tolerant Douglas-fir (*Pseudotsuga menziesii*) stands in southern Oregon, murrelets most often occupied or were abundant in low-elevation slopes with a west-facing aspect, but these sites were not close to streams. Murrelets tended to use areas farther from roads. The important climatic requirements for the stand in both states were a cool temperature and high rainfall.

HOW DO SEX AND REPRODUCTIVE SUCCESS RELATE TO SITE FIDELITY AMONG SNOWY PLOVERS IN HUMBOLDT COUNTY, CALIFORNIA?

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Theory predicts that sex-biased faithfulness of individuals to breeding sites correlates with parental care and reproductive success. Higher parental care investment and reproductive success should correlate with site fidelity. From 2001–2004, I examined these predictions among western Snowy Plovers (*Charadrius alexandrinus nivosus*) in Humboldt County. There was no sex bias in breeding site fidelity among first-time breeders. There was no difference in returns according to hatching success, and, for those that cared for broods, returns were unrelated to fledging success. Among females that returned, nest distances between years were shorter for those that hatched young the previous year than for unsuccessful females. For males, there was no effect of hatching success on inter-nest distances, but males that fledged young had shorter nest distances

between years than failed males. At a larger spatial scale (Humboldt County), the absence of a sex bias in site fidelity and the absence of an association with reproductive success appear to contradict mating system theory, but, among plovers that do return, female fidelity is influenced by hatching success and fledging success affects male fidelity. Managers that focus efforts on protecting Snowy Plover nests with exclosures should also protect broods to decrease the likelihood of female plovers returning to nest in poor-quality reproductive habitat on the local level.

VARIABILITY IN THE FEEDING OF FOUR ATLANTIC SEABIRDS ON MACHIAS SEAL ISLAND, NEW BRUNSWICK [Poster]

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We have ten years of feeding data collected for four species of seabirds breeding on Machias Seal Island (MSI), New Brunswick, in the mouth of the Bay of Fundy. The focal species include two surface-feeding terns, Arctic Tern (*Sterna paradisaea*) and Common Tern (*S. hirundo*), and two pursuit-diving alcid, Atlantic Puffin (*Fratercula arctica*) and Razorbill (*Alca torda*). Previous work on MSI demonstrated that poor weather hindered the feeding and reproductive success of the surface-feeders, but not the pursuit-divers. The summer of 2004 was colder and foggier relative to the previous nine years, and all four species of seabird fed their young poor-quality prey items such as fish larvae, euphausiid shrimp, and insects. The mixed colony of approximately 3,000 tern pairs had a fledging success of less than 5%, while the alcid colony fledged 68–78% of chicks but showed reduced chick growth rates. The 2004 summer is ideal for comparing how different life-history strategies shape productivity as available food types vary between summers and within seasons. In examining inter-seasonal variation, reproductive success differs between the two foraging guilds. On a finer scale, we see that intra-seasonal variation captures the feeding differences between species within the pursuit-diving guild.

CONTRASTING FORAGING TACTICS OF SEABIRDS BREEDING IN DIFFERENT OCEANOGRAPHIC DOMAINS

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Social aspects of foraging behaviour around seabird colonies include the exploitation of colony-specific feeding areas and food information, interference competition, prey depletion, and prey disturbance. Variations in the distributions and densities of ectothermic prey around colonies are driven by oceanographic features and create the ecological rationale for foraging decisions that are often flexible, especially among generalist and opportunistic predators. We show that oceanographic influences shape the foraging tactics of individual seabirds and generate higher-level, colony-specific foraging strategies. In the first North American tests using Global Positioning System (GPS) loggers attached to free-ranging marine birds in, we investigated the foraging tactics of Northern Gannets (*Morus bassanus*) during chick-rearing at two large colonies that differed in oceanographic regime, coastal position, population size, and prey fields.

INSIGHTS INTO THE WINTER ECOLOGY OF MURRES (*Uria aalge* & *U. lomvia*) USING STABLE ISOTOPES

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Winter ecology of Common (*Uria aalge*) and Thick-billed (*U. lomvia*) murre has often been difficult to measure directly due to their highly dispersed nature at sea. For the populations off the coast of Newfoundland, Canada, which are harvested by hunters, we were able to use stable-isotope analysis on collected carcasses to provide insight into murre winter foraging ecology. We used stable carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotopes to investigate information related to diet: carbon-13 indicated offshore/nearshore feeding habitat and $\delta^{15}\text{N}$, in combination with $\delta^{15}\text{N}$ values of prey species, indicated trophic level. We found that Thick-billed Murre fed at a higher trophic level than Common Murre. Within the species, no differences in either foraging location or

trophic level were found between males and females or between years. Hatching-year (HY) Common Murres fed at a higher trophic level than did after-hatching-year (AHY) birds; however, no differences were found between HY and AHY Thick-billed Murres. Both Thick-billed and Common murres showed a significant enrichment in birds $\delta^{13}\text{C}$ during the winter months, indicating that foraging locations shifted nearshore as the winter progressed. Preliminary analysis also suggests that breeding Thick-billed Murres were significantly enriched in $\delta^{15}\text{N}$ compared with wintering birds.

INTER-YEAR DIETARY VARIATION AT A SEABIRD COMMUNITY REVEALED THROUGH STABLE-ISOTOPIC MONITORING [Poster]

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Arctic ecosystems are vulnerable to human-induced changes such as increases in contaminant levels and climatic warming. To predict effects of these changes, it is important to understand trophic relationships among Arctic organisms. We investigated diets within the seabird community (Thick-billed Murres *Uria lomvia*, Northern Fulmars *Fulmaris glacialis*, and Black-legged Kittiwakes *Rissa tridactyla*) of Prince Leopold Island, Nunavut, 2000–2003, to determine the consequences of dietary variation on seabird breeding success. Diet was monitored using stable isotope measurements ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$) in blood samples from the three seabird species. Stable-carbon isotope analysis gives an indication of source of feeding (i.e., inshore vs. pelagic), and a ^{15}N analysis provided an indication of trophic level. We determined significant differences in trophic level and space use among years for all species. Notably, in 2002, the proportion of fish in the diet dropped and the variance in diet increased. Fewer chicks than average for all species were fledged in 2002, and Thick-billed Murre chicks were lighter than in other years. The results suggest that 2002 had reduced fish availability, perhaps as a result of differences in ice conditions in the preceding year.

AT-SEA OCCURRENCE, DISTRIBUTION, AND THREATS TO XANTUS'S MURRELETS IN BRITISH COLUMBIA AND WASHINGTON [Poster]

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Xantus's Murrelet (*Synthliboramphus hypoleucus*) is a northeast Pacific endemic, ranging from about 23° to 53°N. Although first reported in British Columbia (BC) and Washington (WA) in the 1940s, the occurrence of the species in territorial waters was not formally recognised until the 1970s. In 1990, there was only one accepted record for BC, and the provincial status was designated as "Accidental". With the beginning of pelagic surveys in the 1970s and 1980s in WA and BC (respectively), it became clear that Xantus's Murrelets regularly occurred in low numbers in offshore waters. We examine the locations of 82 murrelet sightings (181 individuals) recorded during at-sea surveys, 8 of 10 birds caught in driftnets in 1987, and other historical records. During systematic at-sea surveys, most (~70%) murrelets were encountered in August and September (range June through October). Although found from the continental shelf (<200 m) to pelagic waters (>3,000 m), most murrelets occurred in waters over the outer shelf and slope, placing the species at risk from bycatch in commercial fisheries and from chronic oiling.

REPRODUCTIVE SUCCESS OF BLACK-FOOTED AND LAYSAN ALBATROSSES ON HAWAIIAN REFUGE ISLANDS

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Reproductive success (chicks fledged/eggs laid) and its components, hatching success (eggs hatched/eggs laid) and fledging success (chicks fledged/eggs hatched), for Laysan (*Phoebastria immutabilis*) and Black-footed (*Phoebastria nigripes*) albatrosses were measured at Midway Atoll (1992–2003), Laysan

Island (1992–1995), and French Frigate Shoals (1980–2004). Success varied among sites: e.g., reproductive success at Laysan in 1992 through 1995 was low, whereas reproductive success for the same years from Midway and French Frigate Shoals was not depressed. Correlation Coefficients (r) of success rates of the two species at two sites were high (0.77 and 0.80). Although hatching success estimates ranged from 0.66 to 0.91 over the past 20 years, fledging success estimates have been more variable, ranging from 0.28 to 0.94. Reproductive success on these islands appears to be most strongly influenced by factors influencing fledging, rather than hatching. The 2001 breeding season on both Midway Atoll and French Frigate Shoals showed improved reproductive success (0.50–0.71), after several years (1997–2000) of poor performance, with a low of 0.09 for Laysan Albatrosses at French Frigate Shoals in 1999.

RESTORATION OF TERN COLONIES IN BUZZARDS BAY, MASSACHUSETTS, USA

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Buzzards Bay, a shallow estuary in the northeastern USA, has held important colonies of terns since the earliest historical records. Penikese Island was one of the few colony sites that survived the mass slaughter of terns for the millinery trade in the 1880s. By the 1930s, numbers had increased to about 12,000 pairs of Common and 6,500 pairs of Roseate Terns (15% and 70%, respectively, of the North American populations) at four main sites (Penikese, Weepecket, Ram and Bird Islands). In the period 1940–1970, Herring Gulls occupied all the sites; by 1975, there were only about 800 pairs of Common and 1,000 pairs of Roseate Terns, confined to part of one small inshore island. A restoration program started in 1970 has successively displaced gulls from Bird, Ram, and part of Penikese Islands; total numbers have increased to about 4,500 pairs of Common and 1,600 pairs of Roseate Terns. Gull-control techniques have included shooting, poisoning, nest destruction, and harassment with dogs. The restored sites require continual management efforts to prevent resettlement by gulls, control predators, and manage vegetation on the limited areas suitable for terns. Current plans include a major restoration program at Bird Island to stop ongoing erosion and to restore areas lost to erosion in recent decades.

NEST ATTENDANCE PATTERNS OF BLACK-LEGGED KITTIWAKES: INDICATION OF FOOD AVAILABILITY

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In 2001 and 2002 we assessed patterns of nest attendance of Black-legged Kittiwakes (*Rissa tridactyla*), as well as a suite of commonly monitored reproductive parameters, in Chiniak Bay, Alaska. We continuously monitored the daily presence of telemetered individuals at the colony in 2001 ($n = 29$), and 2002 ($n = 39$) over the breeding season (Incubation, Early Chick, Late Chick). We found differences in the nest-attendance behavior of kittiwakes between years and over the breeding season. As expected, because of increased energy requirements of chicks, kittiwakes with active nests spent a greater proportion of their time away from the colony during the Late Chick stage ($0.61 \pm \text{SE } 0.03$) than either the Incubation stage (0.50 ± 0.03) or Early Chick stage (0.52 ± 0.02). However, breeding kittiwakes spent a smaller proportion of their time away from the colony in 2001 (0.51 ± 0.02) than in 2002 (0.58 ± 0.02). Moreover, they averaged shorter durations of foraging bouts during the Late Chick stage in 2001 (2.6 ± 0.4 hr) than in 2002 (4.3 ± 0.3 hr). These differences can be explained by differences in food availability, as determined by local surveys of the prey base. We conclude that patterns of nest attendance are driven by chick demands and can be used as an indicator of forage availability.

USING CAPTIVE FEEDING TRIALS TO VALIDATE THE FATTY-ACID SIGNATURE TECHNIQUE FOR DIET DETERMINATION IN PISCIVOROUS SEABIRDS

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Fatty-acid signature analysis has been used to study the diets of various marine predators. Fatty acids from dietary sources may be directly deposited into adipose stores. Certain fatty acids, however, may be selectively metabolized or biosynthesized from dietary constituents, so that adipose stores in predators may

contain lower or higher levels of particular fatty acids compared to their diet. Levels of fatty acid biosynthesis and metabolism vary among predator taxa, creating a need to validate each predator species. To compare fatty acid levels in adipose tissue of Caspian Terns (*Sterna caspia*) with that of their diet, we raised tern hatchlings in captivity on four controlled diets consisting of two different fish types. The diet of two groups consisted of either hatchery-raised rainbow trout (*Oncorhynchus mykiss*) or wild Pacific herring (*Clupea pallasii*); the remaining two groups were fed both fish types in two different ratios. Fatty-acid methyl esters were extracted from fish prey and adipose tissue biopsied from chicks. Fatty-acid profiles obtained from these samples will be used to quantify the relationship between levels of each fatty acid in the predator and in the prey and to compare signatures among and between birds fed diets consisting of a single prey type vs. mixed diets. Calibrating levels of particular fatty acids in tern chicks fed controlled diets will enhance interpretation of fatty acid profiles from wild Caspian Terns and other piscivorous waterbirds with unknown diets.

COASTAL OCEAN MAMMAL AND BIRD EDUCATION AND RESEARCH SURVEYS IN CENTRAL CALIFORNIA, 1997–2004

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Since 1997, trained volunteers have conducted monthly beached bird and mammal surveys in the Monterey Bay National Marine Sanctuary. Using standardized survey methods, we have obtained baseline rates of deposition (birds km⁻¹mo⁻¹) of beached birds and identified unusual mortality events related to human activities (e.g., fishery bycatch, oil spills) and natural phenomena (e.g., starvation events). We maintain a network of scientists, researchers, and resource managers to enable early detection and investigation of mortality events. We documented sources of mortality affecting resident species, including Common Murre (*Uria aalge*) and Brandt's Cormorant (*Phalacrocorax penicullatus*); and migratory species, including Sooty Shearwaters (*Puffinus griseus*), Northern Fulmar (*Fulmarus glacialis*), loons (*Gavia* spp.), grebes (*Aechmophorus* spp.), and gulls (*Larus* spp.). Finally, we discuss our efforts to disseminate information to the public and educational institutions via teacher workshops and web-based information systems.

RAKIURA TĪTĪ RESTORATION: MITIGATION OF INJURY FROM AN OIL SPILL IN U.S. WATERS BY ERADICATION OF RATS FROM *PUFFINUS GRISEUS* BREEDING COLONIES IN NEW ZEALAND

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We present an encouraging example of international and cross-cultural collaboration to mitigate the effects of an oil spill on a trans-equatorial migratory procellariid, *Puffinus griseus* (Sooty Shearwater, Tītī). Migratory seabirds are often injured in greatest proportions by coastal oil spills. US Trustee agencies and the legal documents that guide the use of mitigation monies recognize the importance of restoration efforts outside the spill area for injured migratory species. Participation of international Trustees (i.e., bird harvesters, non-U.S. resource agencies) and seabird biologists throughout the process (injury assessment, legal activities, restoration project planning) is needed to wisely target mitigation efforts and funding. We discuss the Rakiura Tītī Restoration Project (RTRP) that seeks to repair injury to Sooty Shearwaters caused by the T/V *Command* oil spill in 1998 off the central coast of California by eradication of introduced rats from breeding colonies on four southern islands of New Zealand. The RTRP has identified four main objectives in order to bring lasting benefits for conservation: (1) eradicate the non-native introduced rats; (2) establish quarantine contingencies to prevent reintroduction of rats; (3) monitor and predict restoration success; and, (4) create educational outreach in New Zealand and California.

HEALTH ASSESSMENTS AND STRESS RESPONSES OF XANTUS'S MURRELETS: DO HANDLING TECHNIQUES AFFECT BIRDS FOR MINUTES, HOURS, DAYS, OR YEARS?

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A small world population, <10,000–20,000 breeding individuals, makes the Xantus's Murrelet (*Synthliboramphus hypoleucus*) one of the most vulnerable seabird species. Concurrent with the small population size is the need to learn more about murrelet biology, physiology, ecology, and natural history, which often requires that birds be captured, handled, banded, and potentially radio-marked. While these activities may appear benign, murrelets undergo a measurable corticosterone mediated stress response to these activities. Measuring the stress response through blood sampling allows an immediate assessment of the murrelet's response, but long-term survival, as determined by recapturing previously banded birds, provides some insight into whether the immediate stress response measured through blood sampling has potentially resulted in a survival disadvantage. In addition to monitoring stress responses of Xantus's murrelets, we established baseline health indices that indicate physiological health from both a cellular and biochemical perspective. Immune status, kidney and liver function, and electrolyte balance were evaluated, and baseline indices can now be used for future health evaluations of Xantus's Murrelets. Results from the stress study and recapture information will be presented, and health parameter results will be discussed in the context of other murrelets for which baseline blood health parameters exist.

ISLAND CONSTRUCTION AND COLONIZATION BY NESTING WATERBIRDS IN NUECES BAY, TEXAS

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Coastal waterbird nesting colonies in Texas are dependent on islands located between extensive barrier islands and the mainland. Several natural islands exist and have historically supported a large proportion of the breeding biomass. Most of the islands currently used by waterbirds were created by deposition of dredge material. Inadequate protection of these islands has resulted in a major loss in available nesting habitat due to erosion/subsidence, invasive vegetation, predation, and human disturbance. Waterbirds are consequently relegated to less favorable habitat, which can result in decreased overall reproductive success. Nueces Bay, in the central coast, has lost over $\frac{2}{3}$ of its islands in the last 30 years, and the islands that remain are drastically reduced in size. In 2001, an island was created with the intention of providing nesting habitat for several waterbird species of conservation concern, especially Black Skimmer (*Rynchops niger*). The protected four-acre island was constructed at a cost of ~\$1.5 million. Bare-ground nesters colonized the site in the first available breeding season, and, in 2004, thirteen species, including wading birds and whistling-ducks, nested on the island. In 2003, we conducted weekly counts during the breeding season. Based on perceived low fledging success of Black Skimmers in 2003, a more intensive effort was made to observe nesting dynamics in addition to weekly counts in 2004. Piracy of Black Skimmers by Gull-billed Terns (*Sterna nilotica*) severely limited the ability of skimmers to feed and fledge young successfully.

POST-FLEDGING SURVIVAL OF LITTLE PENGUIN CHICKS IN RELATION TO HATCHING DATE, PEAK MASS, AND YEAR

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In the 34 breeding seasons 1967/68 to 2000/01, 25,226 Little Penguins *Eudyptula minor* were banded at Phillip Island, Victoria, Australia, at about the time of peak mass, 1–2 weeks before fledging. Through 2003, 784 had been found dead within two years of banding (mostly on beaches away from the breeding colony), and 2,207 had been found alive more than two years after banding (mostly as breeders in the colony). We used logistic analysis of covariance to analyse the dependence of return and recovery rates on banding date and mass

at banding (proxies for hatching date and peak mass, respectively). The probability of being found alive after the age of two years decreased with increasing hatching date and increased with peak mass; both relationships were curvilinear. After controlling for date and mass, the probability of being found alive varied widely from year to year. Data on birds found dead yielded similar and complementary information. Using independently-derived demographic parameters, we estimate the probability of survival from fledging to first breeding as a function of hatching date, peak mass, and year. This probability varied from near 0 for late or light fledglings in poor years to near 1.0 for early or heavy fledglings in good years. Post-fledging survival is an important component of the breeding performance of Little Penguins.

NEW INSIGHTS INTO THE BREEDING AREAS, MIGRATION ROUTES, STAGING, MOLTING, AND LOCAL MOVEMENTS ASSOCIATED WITH SURF AND WHITE-WINGED SCOTERS WINTERING IN THE INNER MARINE WATERS OF WASHINGTON STATE

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Scoters have experienced significant declines in numbers over the last 25 years in the marine waters of Washington State; however little was known until recently of movements and population dynamics of the different wintering scoter populations on the west coast and how they might relate to each other. Studies started in 2003 in Washington using satellite and radio transmitters for the purpose of documenting the patterns of distribution and fidelity to winter and spring foraging areas, night concentrations, migration routes, range of breeding sites, and molting areas of White-winged and Surf scoters wintering in Washington. Two years of a four-year project have now been completed, suggesting: (1) distinct differences in distribution and movement exist between the two main scoter species, between male and female scoters, and between different flyway subpopulations of scoters, such as San Francisco Bay and Puget Sound; (2) male scoters spend 9–10 months and females spend 8–9 months in marine waters each year; (3) western Washington contains important wintering and staging areas used by scoters; (4) scoters return daily and yearly often to the same locations, expressing considerable site fidelity; and (5) several different patterns of scoter association with herring spawning were observed.

BEACHED-BIRD SURVEYS AND SHIP-SOURCE OIL POLLUTION: HOW THE ABSENCE OF KNOWLEDGE DOES NOT MEAN THE KNOWLEDGE OF ABSENCE

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Seabird conservation programmes worldwide incorporate volunteer-networked beached-bird surveys ("BBSs") to monitor variation in mortality rates attributable to marine oil pollution. In Canada, data from BBSs conducted in the Avalon Peninsula of Newfoundland have led to annual oil-associated mortality estimates as high as 300,000 seabirds. Most of this estimated mortality is attributable to the illegal dumping of oily sludge, which inevitably collects in the bilge of ships during normal operations. Comparisons of BBS data between the east and west coasts of Canada, however, have also led to some misguided conclusions. We review factors that can affect the proportion of oiled seabird carcasses documented in BBSs generally and discuss how these factors vary between the Atlantic and Pacific Canadian seaboards. In particular, we determine areas of higher risk of oiling for seabirds and model oiled-carcass trajectories to predict areas along the BC coast where oiled seabirds are most likely to appear. Delineation of oiling-risk areas incorporates data from seabird surveys, shipping information, and marine oil-spill surveys, and the carcass trajectories include both oceanographic and meteorological information. With this model, we improve our interpretation of BBS data and hope to encourage coverage in areas not currently surveyed.

PELAGIC HABITAT HOTSPOTS AS REVEALED BY REMOTE SENSING IN THE NORTH-EASTERN PACIFIC [Poster]

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Identifying elevated oceanic productivity and upper trophic level predator aggregations (pelagic 'hotspots'), and quantifying spatio-temporal persistence of these hotspots at different scales is critical for effective marine conservation from species to ecosystems. We suggest that a cost-effective approach for understanding and predicting seabird distributions at sea incorporates the development of spatio-temporal distribution models that use remote sensing data from satellites. We present preliminary results associating seabird distribution data collected during seasonally and annually replicated Line P cruises (1996–2003), from the entrance of the Strait of Juan de Fuca to Ocean Station Papa (50°N, 145°W), with oceanic fronts as determined by concurrent remote sensing data for sea-surface temperature (SST: AVHRR) and Chlorophyll *a* (Sea-WiFS). For this poster, we have focused on distributions and abundance of dark shearwaters (mostly Sooty Shearwaters *Puffinus griseus*). Future work will include cruise-by-cruise analyses for three other species of seabird (Fork-tailed Storm-Petrel *Oceanodroma furcata*; Leach's Storm-Petrel *O. leucorhoa*; Northern Fulmar *Fulmarus glaciaris*), as well as testing for the presence of fronts and other discontinuities using ship-board data collected during each cruise (i.e. "Loop": continuous sea-surface samples from ship intake).

CLIMATIC WARMING WILL THREATEN BIRDS BREEDING AT HIGH-LATITUDES BECAUSE THERMOREGULATORY COSTS DRIVE MORPHOLOGICAL ADAPTATION

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Allen's rule predicts that, within an endothermic species, the relative size of limbs decreases at higher latitudes. Reducing costs of thermoregulation at cooler latitudes is believed to drive this phenomenon. Responses to a factor as pervasive as thermoregulation, however, should also be observed across species. Though widely cited, all previous studies of Allen's rule have been intraspecific. We present the first interspecific validation of Allen's rule, showing for 45 species of gulls and terns strong latitudinal variation in length of exposed leg elements but not insulated ones. Thermoregulatory costs, therefore, strongly affect the evolution of limbs, rendering cold-adapted species more susceptible to changing thermoregulatory regimes caused by rapid climatic change.

RIGOR, RELEVANCE, AND REGULAR PEOPLE: THE COASTAL OBSERVATION AND SEABIRD SURVEY TEAM

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Relative to terrestrial birds, little is known about the demography of seabirds, including distribution, abundance, and population trends. This is especially true during the winter, when at-sea surveys are difficult and expensive. Documentation of beached birds is a relatively accurate and inexpensive way to collect data regarding demographics, including potential causes of mortality such as winter-kill, oil spills, and gillnet entanglement. Since its beginning in 1999, COASST has collected data on 6,000 beached birds from more than 100 coastal locations throughout the Pacific Northwest, making it the largest beached bird program in the world. Unlike other areas, in which episodic or chronic oiling is significant, along the Pacific Northwest coastline, winter-kill, manifested as species-specific wrecks, appears to be the single most important mortality phenomenon. Total mortality estimates vastly exceed, for instance, those generated by models of local oil spills. A second, only slightly smaller, mortality peak occurs in the local breeders, exemplified by murre and gulls, following the breeding season. Although our data suggest that natural mortality events predominate, there are at least three caveats. First, standardized total deposition on the outer coast has increased every year since data collection started. Second, the COASST dataset is still short-term. Finally, long-term low-level pressures, including chronic pollution, declines in the forage-fish community, and climate forcing, may exacerbate the current mortality pattern.

CHARACTERIZING THE EFFECTS OF CURRENT-USE PESTICIDES ON WATERBIRDS IN NORTH AMERICA [Poster]

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Current-day pesticide use has multiple effects on wildlife and the ecosystems on which they depend. Research indicates that pesticides in the environment have (1) physiological effects on individuals that can cause mortality, significantly alter behavior, life span, and/or reproduction, thus leading to changes in population that can affect sustainability; and (2) ecological effects that can fundamentally alter food availability, prey-predator relationships, and ecosystem characteristics. Despite having substantial regulatory and legislative control over the release of pesticides in the environment, the impacts of these chemicals within the ecological systems to which they are regularly applied are only partially characterized and not well understood, complicating effective management and regulatory and societal response. A better understanding of these effects, especially as they are played out in the variety of field scenarios from the production of specific crops to maintenance of land for pasture or grazing and stewardship of parks and reserves, is critical to ecosystem and species conservation strategies. We provide a comprehensive review of current knowledge regarding the impact of current-use pesticides on aquatic birds—often indicators of highly sensitive habitats and ecosystems. Recent information suggests that direct acute and sublethal effects on birds are common and may contribute to significant impacts on populations. Information on indirect effects in aquatic systems is much less developed.

SURVIVAL RATES AND RATES OF POPULATION CHANGE FOR MARBLED MURRELETS IN CENTRAL CALIFORNIA: EVIDENCE FOR A SINK POPULATION?

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We estimated annual local survival rates for after-hatch-year (≥ 1 -year old) Marbled Murrelets (*Brachyramphus marmoratus*) in central California with Cormack-Jolly-Seber mark-recapture models ($n = 331$) and radio-telemetry ($n = 117$) from 1997–2003. Model-averaged survival estimates were 0.868 (SE = 0.074) and 0.896 (SE = 0.067) for males and females that were not radio-tagged, respectively, and 0.531 (SE = 0.175) and 0.572 (SE = 0.181) for males and females that were radio-tagged, respectively. Analysis of mortalities of telemetered individuals indicated that radio-marking had a major impact on murrelet survival during a Domoic Acid bloom but that effects were much less severe during typical years. Important causes of mortality for murrelets included Domoic Acid (a neurotoxin in the marine environment), predation by Peregrine Falcons (*Falco peregrinus*), and oil spills. We also used three competing methods to estimate the population growth rate for Marbled Murrelets in central California. Based on a Leslie matrix model parameterized with stage-specific birth and survival rates, the population was projected to decline significantly ($\hat{\lambda}_M = 0.908$, SE = 0.054). However, the population did not decline based on at-sea counts and Pradel's mark-recapture models ($\hat{\lambda}_C = 1.058$, SE = 0.047 and $\hat{\lambda}_p = 1.064$, SE = 0.033, respectively), possibly because Pradel models and counts of individuals incorporated immigration processes while the matrix model did not. Thus, our results suggest that Marbled Murrelets in central California may represent a sink population that is stable but would decline by 9.2% per year in the absence of immigration from larger populations to the north.

FORAGING BEHAVIOR OF MARBLED MURRELETS: MEETING REPRODUCTIVE DEMANDS IN A DYNAMIC OCEAN ENVIRONMENT

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We used radio-telemetry to investigate how a pursuit-diving seabird, the Marbled Murrelet (*Brachyramphus marmoratus*), adjusts the effort it devotes to foraging in response to breeding commitments and physical oceanographic factors that affect prey availability in central California. Radio-marked murrelets ($n = 32$) spent more time diving during upwelling events than during relaxation events,; as upwelling events became longer, murrelets traveled shorter distances to foraging locations. The duration of dive bouts was greater during rough sea conditions than during moderate and calm conditions, and both the proportion of time spent diving and the duration of dive bouts declined as the breeding season progressed. Actively nesting birds (1) spent more time foraging than nonbreeders and breeders that were not nesting; and (2) reduced the distance that they traveled from nesting to foraging sites. In general, murrelets increased the effort they devoted to diving and conserved energy by reducing the distance they traveled to foraging sites when reproductive demands were high or food availability, as indexed by physical oceanographic conditions, was low. In particular, we suggest that murrelets foraged more during upwelling events due to the advection of prey from nearshore waters and that murrelets restricted their movements as upwelling events became longer to avoid wasting energy searching for depleted prey. Although murrelets adjusted their foraging behavior in response to both breeding commitments and oceanographic conditions, breeding commitments appeared to play a more important role in determining feeding strategies.

BACKGROUND ON THE 5-YEAR REVIEW AND THE U.S. FISH AND WILDLIFE SERVICE DECISION

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On September 1, 2004, the U.S. Fish and Wildlife Service completed its formal 5-year review of the Marbled Murrelet, concluding the population of murrelets in California, Oregon, and Washington does not satisfy the criteria for designation as a Distinct Population Segment (DPS) under the Service's 1996 DPS Policy. The Service's analysis concluded there is no marked separation of physical, physiological, ecological, or behavioral differences at the U.S. and Canadian border, and no significant evidence of genetic or morphological discontinuity between populations at the border. The results also show that there are no differences in control, exploitation, management of habitat, conservation status, or regulatory mechanisms across the international border that are significant. While the California, Oregon, and Washington population does not qualify as a DPS, the question of whether the three-state population constitutes a significant portion of the range of the species, or whether the species as a whole is at risk of extinction, still needs to be addressed before any change in the listing status occurs. Delisting or reclassifying the murrelet under the Endangered Species Act will require a separate rulemaking, involving public notice and comment.

LARGE-SCALE MOVEMENTS AND HABITAT USE OF KING EIDERS THROUGHOUT THE NONBREEDING PERIOD

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King Eiders molt wing feathers and overwinter in remote areas of the Bering Sea, precluding direct observation of the birds at this time. To characterize the timing of migration and habitat used by King Eiders during the non-breeding period, we derived the location data of 60 individuals (27 females and 33 males) from satellite telemetry and oceanographic information from remotely sensed data. Male King Eiders dispersed from breeding areas earlier, arrived at molt sites earlier, and remained at molting locations longer than females. Males that arrived at molting sites earlier molted at higher latitudes. King Eiders that wintered farther south returned to breeding areas earlier the following summer. Distributions of molting and wintering locations did not differ by sex, year, or capture location. General linear models suggest that the variables distance to shore, water depth, and salinity best describe King Eider habitat throughout the non-breeding period. During the

winter, lower ice concentrations were also associated with King Eider locations. This study provides some of the first large-scale descriptions of King Eider migration and habitat use outside of the breeding season.

GLOBAL CLIMATE CHANGE AND ABLATION OF THE GLACIER MURRELET

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Cooling climate in the late Pliocene was accompanied by rapid speciation among the Alcidae. Several new species of *Brachyramphus* murrelets evolved, and one that survived to our time, Kittlitz's Murrelet (*B. brevirostris*), developed an unusual and intimate association with glacial ice during the Pliocene and subsequent Pleistocene ice ages. Kittlitz's Murrelets usually nest in the high alpine, on recently deglaciated mountain peaks, and forage in glacially modified marine waters. Today, the "Glacier Murrelet" is found only in areas with extensive ice sheets (e.g., Glacier Bay NP, outer coast of Wrangell-St. Elias NP, Prince William Sound, Kenai Fjords NP, Kachemak Bay), remnant glaciers (e.g., Alaska Peninsula, a few Aleutian islands), and in a few areas that once contained extensive ice fields but are now glacier free (e.g., Seward Peninsula). Surveys conducted in areas containing the bulk of their numbers in Alaska indicate that populations have declined by >80–90% during the past 15 years. This corresponds to an almost universal and increasingly rapid recession of glaciers and ice fields throughout Alaska, which itself is a result of global warming.

STATUS OF MARBLED MURRELET POPULATIONS IN ALASKA

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Estimated entirely from surveys at sea, the total population of Marbled Murrelets (MAMU) in Alaska during the early 1990s was probably in the order of half a million birds. Some population surveys were repeated using the same methods each year, so we can assess population trends in a few areas. At Glacier Bay in SE Alaska (where 100,000s of murrelets resided historically), summer populations of MAMU declined by 75% between 1991 and 1999/2000, with a 17.5% per annum rate of decline ($P < 0.05$). Other than Kittlitz's Murrelet (–18.8% pa), populations of all other species of marine birds are stable or increasing. In Prince William Sound (10,000s of murrelets), summer populations of MAMU declined by 85% since a single census in 1972 and by about 65% since repetitive annual surveys began in 1989 (a –6.6% pa decline since 1989; $P < 0.01$). Along the Kenai Peninsula (1,000s of murrelets), summer populations declined by 62% from 1976 to 1989 but increased 5-fold between 1989 and 2002. Counts of wintering murrelets on surveys around Kodiak (annually since 1980) and on Christmas Bird Counts show no trends but suggest cyclical patterns of winter attendance, perhaps related to climate. We will discuss threats to MAMU populations and possible causes for the alarming decline in their summer breeding populations.

LARGE-SCALE BREEDING FAILURE AT A CENTRAL CALIFORNIA COMMON MURRE COLONY DUE TO COMMON RAVEN AND BROWN PELICAN DISTURBANCE AND PREDATION [Poster]

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In 1996, a collaborative restoration project was implemented to restore Common Murre colonies along the central California coast that were impacted by oil spills. The resulting monitoring at one colony, the Castle/Hurricane Colony Complex, has documented periodic disturbance by juvenile Brown Pelicans on breeding murre colonies since 1997. Disturbance events have contributed both directly and indirectly to egg and chick loss within the colony. In 2003, a pair of Common Ravens began harassing the colony, causing several flushing events and depredation of at least three chicks. In 2004, frequent disturbance by nesting ravens caused the abandonment of one murre subcolony before egg-laying and high levels of egg depredation. Also, during the late incubation/mid-chick period in 2004, a juvenile pelican almost continuously harassed murre colonies on several nesting rocks over a period of nine days. Flushing events exposed eggs and chicks, many of which were taken by ravens and gulls, and led to nearly complete reproductive failure on six of eight murre subcolonies. These

events demonstrate the sensitivity of nesting murrets to avian and other forms of disturbance and pose yet another threat to this depleted colony. The unusual pelican behavior is still not fully understood.

INLAND PIPING PLOVER MIGRATION STOPOVER SITES: USING BIRDERS' REPORTS TO STUDY MIGRATION PATTERNS AND HABITAT USE

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The Great Lakes population of Piping Plovers (*Charadrius melodus*) has been extensively studied, but knowledge about migration ecology is limited; this information is needed for recovery. Because the population is small (~50 breeding pairs), tracking individual birds is not feasible. This study compiled records (e.g., state atlases, bird journals) of Piping Plover sightings from a "hypothetical migration pathway" used by Great Lakes birds between winter and breeding sites. Data were used to identify current and historic stopover sites and sites to visit to study habitat characteristics. Additionally, we examined chronology and spatial patterns of migration between the breeding and wintering grounds. We located >1,200 fall and spring stopover records and visited >15 sites to measure habitat characteristics. Results show that Piping Plovers use sites throughout the migration pathway during both fall and spring. Habitat used was shoreline of reservoirs, natural lakes, and rivers. Finally, reports indicate that plovers do not concentrate in large numbers at inland stopover sites and that site use is highly influenced by local water levels and water-management policies.

NEAR-SHORE FORAGING BEHAVIOR OF MARBLED MURRELETS IN SOUTHEAST ALASKA [Poster]

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The Marbled Murrelet (*Brachyramphus marmoratus*) is an alcid that nests in old-growth forests and lives and forages at sea. Marbled Murrelets are found along the Pacific coast and are considered threatened in Washington, Oregon, California, and British Columbia but have a relatively large population in Alaska. Our objectives were to study the near-shore diving behavior of murrelets as compared to populations in threatened areas and to examine the influence of a pre-dive head crouch on dive times. Observations were made at Point Bishop, near Juneau, Alaska. Birds were observed from land during all stages of tide and over all daylight hours on 4 days in mid July. We recorded 2,875 behavioral observations on 240 birds, including 1,289 dives. The mean dive time was 26.79 s (SD = 9.7 s), and the mean recovery surface time was 11.31 s (SD = 8.7 s). The pre-dive head crouch was noted present 321 times and absent 387. We examined the relationship between dive and recovery time and tested the effects of pre-dive head crouch, tidal stage, time of day, and group size on the dive and recovery surface times.

WHY DO CORMORANT EGGS HAVE LOW MERCURY LEVELS AT HALEJI LAKE (PAKISTAN)? JACANA'S TEST

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During a study of the pollution levels by Hg and Se in birds of the Haleji Lake (Pakistan), we observed that eggs of Little Cormorant (*Phalacrocorax niger*) showed unexpected significantly lower levels of Hg in relation to other fish-eating birds (egrets). However, such levels were similar to those in eggs of Pheasant-tailed Jacanas (*Hydrophasianus chirurgus*), a surface predator which may include a variable proportion of plant material in its diet. To assess that such similarity did not derive from similar diets, we used C and N stable-isotope analysis (SIA). Results indicate that jacanas exploited a lower trophic level than cormorants (¹⁵N) and that both species foraged at different places within the lake (¹³C). We have no data on SIA for egrets, but we studied their chicks' diet (mostly fish) and have data for Se levels in their eggs. Se levels discriminate very well between trophic levels, being significantly higher in cormorants and egrets than in jacanas. Since

biomagnification cannot be argued to explain Hg level similarity between cormorant and jacana eggs, we propose a model of differential Hg bioavailability in compartments exploited by both species.

THE ISOTOPIC SIGNATURE OF ^{34}S AS AN INDICATOR OF MARINE RESOURCES IN DIET: YELLOW-LEGGED GULLS IN THE WESTERN MEDITERRANEAN, SPAIN [Poster]

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We investigated the diet of Yellow-legged Gull (*Larus michahellis*) fledglings in different colonies along the Spanish Western Mediterranean coast. We collected regurgitates and mantle feathers of fledging chicks to explore the correspondence of ingested diet composition with signatures of C, N, and S stable isotopes. The proportion of marine resources (mostly fish) in the fledgling's diet is rather variable, from almost 100% in Columbretes Is. to only 20% in Mazarrón. The signature of ^{34}S is also significantly different for every gullery and is higher for those localities with larger consumption of marine resources (Spearman $\rho = 0.468$, $P < 0.001$). A further analysis of this relationship, comparing the differential individual use of marine resources within every locality, reveals that differences are significant both at the Ebro Delta and Mazarrón, suggesting the existence of individual specialists in the use of the different resources. Conversely, differences are not significant for Columbretes Is., because only marine resources are used, nor for Medes Is., probably because gulls at this place are using, simultaneously or consecutively, marine resources and refuse dumps.

ERADICATION OF FERAL CATS AT WAKE ATOLL

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At Wake Atoll, we began an effort to eradicate feral cats beginning in July 2003. By January, 2004, about 170 cats were removed from the three islets of the 2.5-mi² atoll. Despite six weeks of extensive searching in the summer of 2004, no evidence of any cat sign was detected, and no sightings have been made since then. The benefits to seabirds of removing the feral cats were immediate. Bird populations began to increase as cat control was initiated. Masked Boobies increased from 3 breeding pairs in 1996 to 20 by 2004; Brown Boobies went from 73 nests in 1996 to 162 in 2003. Wedge-tailed Shearwater populations expanded to form at least three colonies, with individuals seen at many places around the atoll. Gray-backed Terns, not recorded breeding on the atoll since the 1980s, were nesting in two new sites. Due to feral cat removal and wet weather, Pacific rats have also increased. Current rodent control effort is less effective than it should be because hermit crabs eat the bait before the rats can. Effective rat control requires a method of placing poison bait without hermit crab interference. A bait station model design to exclude crabs is being tested. Rodent populations have declined since their initial high point. Both the island contractor and Air Force are investigating rat-eradication options.

RECOVERY OF SEABIRD BIODIVERSITY AND ECOSYSTEM FUNCTION 25 YEARS AFTER CAT ERADICATION AT JARVIS ISLAND

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Feral cats introduced during the 1930s to Jarvis Island National Wildlife Refuge in the Central Pacific Ocean virtually extirpated six species of terns and procellariids. With the removal of most cats in 1982, seabird population recovery and recolonization began. In 1990, the last cat was removed, and the island was free of predators, although mice remained. With cat eradication, previously extirpated seabirds began to recolonize Jarvis Island in the following order: Gray-backed Terns, Brown Noddies, Blue Noddies, Christmas and Audubon shearwaters, and Polynesian Storm-Petrels. By 2001, the finding of several of Polynesian Storm-Petrels completed the known seabird biodiversity and, by April 2004, seabird populations appear to have recovered to pre-exploitation levels. In particular, we estimated that 650 Blue Noddies were present, revealing local ecosystem processes previously hidden by cat predation. Jarvis Island is directly in the path of the high-

velocity core of the Equatorial Undercurrent (EUC) that flows unimpeded for over a thousand miles before striking the subsurface of Jarvis. This submarine current surfaces cold, nutrient-rich water to where zooplankivorous Blue Noddies and other marinelife benefit. Feral cats, as top food chain carnivores, previously masked the terrestrial expression of this phenomenon. The relatively high numbers of Blue Noddies, one of the highest densities in the world, and the observation that Jarvis was one of the most productive guano islands during that period of exploitation, is now apparent as oceanographic processes are better appreciated. Insights like these help direct future eradication work where local oceanographic conditions are amenable for enhanced restoration values.

ISLAND RESTORATION AND ENHANCEMENT: SUCCESSES, FAILURES, AND TOOLS FOR THE 21ST CENTURY

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[No abstract was received]

COUNTING THE COUNTLESS: ESTIMATING THE SIZE OF AUKLET COLONIES [Poster]

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Least Auklets are likely the most abundant nesting seabird in the North Pacific, but population estimates have been largely conjectural and highly variable among observers. The difficulty in accurate estimation results from erratic attendance of birds at colonies and numbers often too large to count accurately. We developed a new technique for estimating colony size from spatial density and presence/absence data collected in a randomized grid survey of colony extent and applied the technique at St. George Island, Alaska, in June 2004. The colony was surveyed systematically for indirect evidence of nesting density, and we translated relative densities into absolute densities using attendance counts including a known population of color-banded individuals. Birds present on the surface of the nesting colony were counted on 14 plots on three different days during the incubation period. We predicted density of birds attending the surface of the colony from counts of feathers and droppings on sampling plots. Mark-resight data were used to estimate the proportion of birds living on a plot that were observed during our surveys. We used spatial interpolation to estimate auklet density, and we present the first population estimate for any auklet colony that is based on repeatable, georeferenced spatial data.

EFFECTS OF OIL EXPOSURE ON ENERGETICS OF CAPTIVE HARLEQUIN DUCKS

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Harlequin Ducks wintering in areas of Prince William Sound (PWS), Alaska, contaminated by the 1989 *Exxon Valdez* oil spill showed elevated levels of CYP1A, an enzyme induced upon exposure to hydrocarbons, 9 years after the spill. However, effects of exposure on individual health are poorly understood. One potential consequence of oil exposure is an increase in metabolic costs. Because Prince William Sound is near the northern range limit for Harlequin Ducks, any additive energy demands related to exposure to oil could affect survival. To evaluate the hypothesis that exposure to oil increases energy demands in Harlequin Ducks, we measured oxygen consumption, daily energy expenditure (DEE), and food consumption of captive Harlequin Ducks in controlled oil-dosing and plumage-oiling experiments. Although CYP1A was induced in oil-dosed birds, we found no differences in oxygen consumption, DEE, or food consumption between dosed and control treatments. However, plumage-oiling increased oxygen consumption and DEE. These results suggest that plumage-oiling would have stronger effects on energetics than oil ingestion for birds wintering in oil-contaminated areas of PWS, if long-term external exposure was occurring. Further, although induction of CYP1A indicates hydrocarbon exposure, our results suggest it is not necessarily associated with increased energy requirement if the route of exposure is ingestion.

TYPE E BOTULISM-CAUSED WATERBIRD MORTALITY IN THE NEW YORK WATERS OF LAKE ERIE AND LAKE ONTARIO

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Department of Environmental Conservation staff are familiar with outbreaks of Type-C botulism, which periodically cause heavy mortality. Type-E botulism, and its devastating effect on migrating waterbirds, is a new phenomenon. The first observed outbreak in the eastern basin of Lake Erie occurred November 2000. To monitor and evaluate the impact of Type-E botulism on waterbirds, thirteen 500-m transects were surveyed along the Lake Erie shoreline. This survey was replicated during fall 2001, 2002 and 2003. During 2002 and 2003, surveys were also conducted along the Lake Ontario shoreline. Forty-seven transects were monitored during the peak of Common Loon migration, 16 October–14 November. Predicted mortality for the Lake Erie shoreline was calculated. During 2000, an estimated 5,415 waterbirds died from Type-E botulism, while, during 2001, 2,862 waterbirds were impacted. Waterbird mortality continued on Lake Erie during 2002 and was first documented on Lake Ontario. Total predicted waterbird mortality was estimated to be 18,292 for 2002 and 4,610 for 2003. The single waterbird species with the greatest mortality differed each year. Red-breasted Merganser had a predicted mortality of 2,479 in 2000; Common Loon 1,149 during 2001; Long-tailed Duck 13,219 in 2002; and Common Loon 2,101 in 2003.

USE OF BLACK OYSTERCATCHER (*Haematopus bachmani*) DIET AND FORAGING HABITS TO ASSESS THE EFFICACY OF THE VANDENBERG MARINE ECOLOGICAL RESERVE [Poster]

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The Vandenberg Marine Ecological Reserve (VMER) was established in 1994 and protects approximately 12.8 km of coastal habitat at Vandenberg Air Force Base (VAFB). The Black Oystercatcher (*Haematopus bachmani*) is a long-lived, monogamous shorebird that establishes territories in rocky intertidal habitat for foraging and breeding. To learn more about oystercatcher diet and foraging habits and to investigate their role as possible indicators of rocky intertidal health, we determined the number and size of oystercatcher foraging territories found inside and adjacent to the VMER. We identified 5 territories inside and 2 territories adjacent to the VMER. Mean territory size inside the VMER was larger than adjacent territory size. We also collected samples of diet items fed to chicks from one territory and made observations on foraging adults from another territory. There was no difference in prey species composition between the two territories. However, prey items delivered to chicks were larger than those consumed by adults. Additionally, we observed adults foraging in only a small fraction of their total defended territory. The results of this pilot year support the idea that Black Oystercatchers can be useful indicators of marine reserve efficacy and the overall health of rocky intertidal communities.

SEAS: SANCTUARY ECOSYSTEM ASSESSMENT SURVEYS BEACH WATCH

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Beach Watch is a long-term shoreline monitoring program of the Gulf of the Farallones National Marine Sanctuary (GNFMS) and is part of the Sanctuary Ecosystem Assessment Surveys (SEA Surveys). One of the objectives of the Beach Watch program is to assess the spatio-temporal patterns of beached birds along the central and northern California coast. Illustrating the importance of beached-bird monitoring programs, Beach Watch data have been used for early detection of mortality events, as well as assessing impacts from oil spills. Beach Watch has provided data for various damage assessment settlements, as well as contributed information to the scaling and type of restoration projects. Beach Watch provides experienced wildlife reconnaissance surveyors who can quickly survey local beaches, collect oil and oiled wildlife, aid in the direction of response and clean-up efforts, and assess the change in use of the beaches by many taxa of marine organisms and humans. Beach Watch is a part of the GNFMS's SEA Surveys, linking all of the monitoring data collected by the sanctuary and providing biological observation data and habitat characterization for the Gulf of the Farallones and Bodega regions. SEA Surveys include monitoring of the shoreline, intertidal and pelagic

habitats, and physical environmental data. These monitoring programs deliver data useful to the national effort to Integrate Ocean Observing Systems.

USING RADIOTELEMETRY TO TRACK KITTLITZ'S MURRELET IN GLACIER BAY NATIONAL PARK, ALASKA: A PILOT STUDY

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As part of an on-going study of at-sea habitat use, we captured 20 Kittlitz's Murrelets (*Brachyramphus brevirostris*) in Glacier Bay, Alaska, during May 2004. All birds were weighed, measured, photographed, had blood drawn, and had a radio-transmitter affixed before being released. Our capture effort was confined to the West Arm of Glacier Bay, where birds were generally found offshore and in deep water at night. Birds with active transmitters were relocated from a variety of platforms, including fixed-wing aircraft, motorized vessels, kayaks, and land-based observers. All 20 birds captured in the study were relocated at least once during the course of the summer. Overall relocation success (total relocations/possible relocations) was 64%; aerial-based relocation success (73%) was significantly greater than boat-based relocation success (59%). Due to permitting constraints, we were forced to glue on all radio transmitters used in the study, and we feel this had a significant negative impact on transmitter-retention time and, thus, our ability to track birds for an extended period of time.

TEMPORAL AND SPATIAL VARIABILITY IN DISTRIBUTION OF KITTLITZ'S MURRELET IN GLACIER BAY [Poster]

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We are just beginning to understand the pelagic ecology of Kittlitz's Murrelet (*Brachyramphus brevirostris*) and factors that influence their distribution at sea. Surveys conducted annually in Glacier Bay (1999–2003) and at daily, weekly, and seasonal time scales (2003) provide some insight into the pelagic life of this enigmatic seabird. The distribution of Kittlitz's Murrelets in June was concentrated in the lower half of Muir Inlet, a dynamic area of upwelling and glacially-fed river outflow. The area around Russell Island in the upper West Arm of the bay was also an area of high murrelet concentration, particularly the areas directly influenced by tidewater glaciers, including Reid Glacier and Lamplugh Glacier. The density of Kittlitz's Murrelets in the West Arm was highest in July and lowest in August, while the density of Kittlitz's Murrelets in Muir Inlet decreased throughout the season from a high in June to a low in August. While Kittlitz's Murrelets were observed in shallow, nearshore water (often in the vicinity of tidewater glaciers and glacial-river outflows), they were also found in deep water, far from shore and any direct glacial influence.

NEW TECHNIQUES FOR MAPPING FINE-SCALE DISTRIBUTIONS OF BIRDS AT SEA: A CASE STUDY INVESTIGATING COMPETITION BETWEEN MURRES AND MURRELETS

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Boat surveys are typically used to map the distribution and abundance of birds at sea, yet sightings are limited to snapshot observations of birds along a narrow transect line, and boats may flush birds being counted. Alternatively, cliff-top vantages allow prolonged and repeated observations over a broader area without disturbing birds. We used a cliff-top digital theodolite to map fine-scale seabird distributions along two 8 x 4 km segments of the Vancouver Island coast. This technique has been used extensively in marine mammal research but rarely with seabirds. We applied this technique to investigate potential at-sea competition between Common Murres (*Uria aalge*) and Marbled Murrelets (*Brachyramphus marmoratus*). Spatial analysis showed seasonal changes in patterns of murrelet habitat use with increasing numbers of murres. When murre abundance was low, murres and murrelets exhibited similar spatial clustering and overlapped in foraging locations. As murre abundance increased, the two species showed less overlap in foraging locations: murrelet distributions were clustered and restricted, while murres dispersed widely. These data suggest that murrelets may compete for foraging space with murres. Other applications of theodolites in marine ornithology include tracking dive or

flight patterns of individual birds, and studying the effects of boat traffic, fishing, and other human activities on nearshore birds.

SEA-ICE EXTENT AND CURRENT DYNAMICS INFLUENCE DIET AND PRODUCTIVITY OF PLANKTIVOROUS AUKLETS ON THE BERING SHELF [Poster]

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There is increasingly powerful evidence of long-term reduction in the extent of sea ice in the Bering Sea, as well as in the Arctic overall. As sea ice cover continues to decrease, it will have marked effects on both physical and biological processes in the northern Bering Sea. We studied diet and reproductive success of Least Auklets (*Aethia pusilla*) on St. Lawrence Island, Alaska, from 2000 to 2004. During this 5-year period, there was notable variation both in ocean conditions, like sea-ice extent, and in diet composition of Least Auklets. Past studies have shown the importance of the Anadyr Current, a cold, nutrient-rich flow of oceanic water from the productive continental slope region of the Bering Sea, in facilitating the spectacular abundance and diversity of seabirds nesting on the volcanic islands of the inner Bering Shelf. We found a positive correlation between sea ice extent and the predominance of high-lipid oceanic copepods (*Neocalanus* spp.) in Least Auklet diets. We suggest a mechanism whereby sea ice extent and the subsequent strength of the Anadyr Current influence the taxonomic composition of zooplankton communities on the Bering Shelf and, ultimately, the diet composition and productivity of breeding auklets.

XANTUS'S MURRELET BREEDING BIOLOGY RELATIVE TO OCEAN CLIMATE AND PREY AVAILABILITY IN THE SOUTHERN CALIFORNIA BIGHT: TRENDS, INTERANNUAL VARIABILITY, AND CONSERVATION IMPLICATIONS

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We investigated the relative importance of ichthyoplankton prey to the breeding biology of Xantus's Murrelet. In particular, we tested the hypothesis that larval northern anchovy (*Engraulis mordax*) is of importance to timing of egg-laying and annual productivity of the murrelet population on Santa Barbara Island (SBI). We coupled the Channel Islands National Park (CINP) Seabird Monitoring Database with estimates of prey abundance using CalCOFI net samples over 19 years, 1983–2001, and focused on anchovies, Pacific saury (*Cololabis saira*), rockfish (*Sebastes* spp.), and “small plankton volume” (consisting primarily of euphausiids). We found significant interannual variation and substantial evidence of time trends in breeding parameters, with higher productivity in 1999–2001. Paradoxically, the abundance of larval anchovy decreased in a secular fashion throughout the time series, with lowest values from 2000–2001. Concurrently, the relative abundance of other potential prey, notably saury and “small plankton” increased. We found significant relationships between the timing of egg-laying and upwelling and “small plankton” abundance. We found significant relationships between clutch size and “small plankton” abundance. Given the increase in reproductive success in recent years during a period of anchovy decline and correlations with “small plankton,” we conclude that the SBI population of Xantus's Murrelet is less reliant on anchovy than was previously thought. Moreover, like other seabirds in the southern California Current System, Xantus's Murrelets appear to be responding to the positive ocean climate regime shift of 1998–1999. This bodes well for the conservation of the species, assuming a generalist diet in light of declining anchovy abundance.

CONTAMINANTS IN STORM-PETRELS FROM ST. LAZARIA ISLAND, ALASKA MARITIME NATIONAL WILDLIFE REFUGE [Poster]

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There are few data on contaminants in Fork-tailed and Leach's Storm-petrels, which travel extensively between nesting and wintering habitat. Such data are needed for baseline information, particularly due to these

species' vulnerability to oil spills and contaminants at-sea. Because storm-petrels feed on surface floating debris and boat discharges, they can easily ingest oil and plastics in surface slicks. They also feed on small pieces of fat from marine mammal carcasses and so may accumulate metals. While organic pollutant data sets for other Alaska seabird species exist, there are no complete data sets on storm-petrels from Southeast Alaska. St. Lazaria Island, near Sitka, is one of two similarly sized Fork-tailed and Leach's storm-petrel breeding colonies in Southeast Alaska. Addled eggs and one dead chick of Fork-tailed and Leach's storm-petrels were collected in 1999 from nest burrows on St. Lazaria Island for organic-contaminants analyses. Contaminants data from one egg collected from St. Lazaria in 1992 are also discussed. Eggs were analyzed for PCB congeners, an organochlorine scan including chlordanes, dieldrin, mirex, toxaphene, and DDT and its derivatives. Overall, St. Lazaria samples contained low concentrations of contaminants that do not represent a risk to populations and were generally similar to those reported in other seabird species' eggs. However, these concentrations were greater than those reported from British Columbia seabird colonies in the last decade.

IS SIZE OF A GULL'S LAST-LAID EGG INFLUENCED BY FOOD AVAILABILITY? EVIDENCE FROM A STABLE-ISOTOPE EXPERIMENT

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The smaller size of last-laid eggs is a characteristic of many gull and tern clutches and has been explained both through adaptive and non-adaptive hypotheses. Among the non-adaptive ones, constraints related to food availability have been postulated to explain this size difference. This presumes that the major egg component determining the observed egg-size variation (i.e., albumen content) is formed according to an income-based strategy (directly derived from dietary materials). To investigate this point, we provided supplements in the pre-laying and laying period to Yellow-legged Gulls (*Larus michahellis*) breeding at the Ebro Delta (NW Mediterranean). The supplements were either soja (SO) or sardine (SA) sausages, thus providing a supplement showing clearly different plant- or animal-based N¹⁵ signatures. A control and two experimental groups were designed that varied in the supplement provided before and during laying (SO to SA and SA to SO). Our results indicate that, in clutches of three, contrary to the first two eggs, the albumen of third eggs is not influenced by the signatures of the supplement provided and, therefore, that last-laid egg albumen (i.e., the size of the last egg) is not dependent on dietary resources.

BEHAVIORAL RESPONSE OF WINTERING WATERFOWL TO WASTE RICE DEPLETION IN THE MISSISSIPPI ALLUVIAL VALLEY [Poster]

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Habitat conservation planning by the Lower Mississippi Valley Joint Venture is based on the assumption that carrying capacity of winter habitats for waterfowl is limited by food availability. If true, as food is depleted over winter, we would predict that waterfowl respond by changing their foraging patterns. We collected time-activity data from mallards and northern shovelers in 80 roadside rice fields during 2 winters (2000–2001 and 2001–2002) in Arkansas to test the hypothesis that foraging effort increases through winter as waste rice is depleted. Using explanatory variables year, date, daily minimal temperature, weekly cumulative precipitation, and field type (internal levees vs. no internal levees), we developed 37 candidate regression models and used an information theoretic approach (AICc) to select the model that best explained trends in foraging effort and changes in foraging mode during winter. The best models for both species included date, field type, and date*field type interaction ($0.34 < R^2 < 0.37$ for Mallards; $0.23 < R^2 < 0.45$ for shovelers). Foraging effort changed with date for both species, but only in unleveed fields. Foraging patterns of Mallards, a granivore, were consistent with rice depletion, whereas patterns of shovelers, feeding less on rice, were not.

RICE DEPLETION BY WINTERING WATERFOWL IN THE MISSISSIPPI ALLUVIAL VALLEY [Poster]
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Conservation and biological planning by the Lower Mississippi Valley Habitat Joint Venture assumes carrying capacity of winter habitats for waterfowl is limited by food availability. However, food abundance and extent of overwinter depletion in the Mississippi Alluvial Valley (MAV) are unknown. We tested the hypothesis that foods are depleted prior to waterfowl departure for breeding grounds. First, we sampled rice fields ($n = 40$ [2000–2001], $n = 72$ [2001–2002]) throughout the MAV during early and late winter to measure the overwinter change of waste rice biomass in fields. Second, we used exclosures placed in a subset of our sample fields ($n = 8$ [2000–2001], $n = 20$ [2001–2002]) to estimate depletion attributable to ducks. Lastly, we used an experiment to determine if depletion of waste rice by foraging waterfowl differed in rice fields of varying initial rice densities ($n = 12$ total; 2–5 of each harvested [140 kg/ha], partially-harvested [1,500 kg/ha], unharvested rice [6,000 kg/ha]), and if giving-up densities differed from the hypothesized threshold of 50 kg/ha. Mean rice densities declined 69% through winter, waterfowl consumed 30–55% of rice, and giving-up densities did not differ from 50 kg/ha. Our results indicate that, by late winter, rice seed resources have been depleted throughout the MAV.

CATEGORIZATION OF THE MARBLED MURRELET VOCAL REPERTOIRE [Poster]
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Marbled Murrelets (*Brachyramphus marmoratus*) are solitary nesters on large tree limbs in mature coastal forests from Southeast Alaska to Central California. This seabird calls frequently during inland flights from marine feeding sites to their nests, and the number and type of vocalizations can be recorded during dawn surveys. However, there is no published extensive description of their vocal repertoire. Our research aims to categorize vocalization types based on the acoustic features of the calls. We have isolated approximately 2,500 calls from tape recordings of murrelets made in California and Oregon between 1990 and 1995. We used both objective and subjective methods to categorize calls. We first subjectively assigned calls to call types. We then randomly sampled 500 calls, including at least 25 of each subjective call type. We measured acoustic features from each of these 500 calls, including call length, maximal and minimal frequency, frequency bandwidth, number of harmonics, and frequency of maximal amplitude. We used Principal Components Analysis to test whether the acoustic features of these calls allowed them to be sorted into discrete categories. Results will provide researchers with basic information about Marbled Murrelet bioacoustics and may help researchers use acoustics in accurately assessing Marbled Murrelet abundance.

THE STUDY OF MERCURY AND STABLE ISOTOPES IN FEATHER SERIES: COUPLING MOULT AND MIGRATION IN AUDOUIN'S GULLS [Poster]
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One of the main aspects when using stable isotopes of feathers to assess migration is the knowledge of timing in the moulting pattern. The Audouin's Gull has a complete post-breeding moult of primary feathers, starting by the innermost one (p1) and progressing outwards up to the last fully developed one (p10). Soon after having completed their breeding period in the Mediterranean waters, they migrate to winter quarters located in Western African coasts; thus moult of primary feathers starts at the breeding locality and ends up in the winter grounds. To identify the changes associated with foraging in different ocean basins, stable isotopes ¹⁵N and ¹³C have been analysed in complete series of primary feathers in the corpses of 12 individuals sampled in 1995, 6 males and 6 females, from the Chafarinas Islands. ¹⁵N profiles indicate that there were not differences in trophic

status between breeding and wintering areas, but ^{13}C was very sensitive to moving between different ocean basins. ^{15}N profiles also shed light when interpreting Hg concentrations in feathers, suggesting that not only p1 was affected by the excretion of Hg in excess, but this extended through the complete moult of the primaries.

MIGRATORY CONNECTIVITY IN AUDOUIN'S GULL

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The Audouin's gull is a species breeding exclusively in the Mediterranean waters. Although abundant information is available on the biology and the trophic ecology of their breeding populations, little is known about its migratory patterns or about its distribution or the conditions it could face in wintering areas. To acquire knowledge about migratory connectivity between breeding and non-breeding populations, we have analyzed mercury, selenium, and stable-isotope signatures (N, C, and S) in gulls belonging to the two main breeding colonies: the Ebro Delta and the Chafarinas Islands. Analyses were done in first primary feathers grown during the summer and in mantle feathers grown during the winter. The stable-isotope differences found in primary feathers from both areas agree with the observed differences in diet between the two colonies. In mantle feathers, isotope signatures do not differ, thus suggesting that both populations share a common wintering quarters. Moreover, N and C values in mantle feathers, which resemble those of primary feathers from the Ebro Delta, suggest that gulls can exploit fish discards also during the winter. The results for Hg also support this hypothesis, although the excretory role played by primary feathers for Hg accumulated in excess preclude its use as a biomarker of breeding locality.

ISOTOPE STUDIES IN ANIMAL ECOLOGY: AN INFORMATIONAL DATABASE [Poster]

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Stable isotopes represent a valuable source of information for a wide range of avian research questions. Examples of research areas using stable isotopes include studies of contaminants, diet, food webs, geographic origin, migration, and resource use. We constructed an informational database on the use of stable isotopes in studies of animal ecology with the purpose of providing an easy to use tool and source of information for both novices and experts in the field. The database uses Microsoft Access as a platform and currently contains information on over 200 journal citations (over 75 articles associated with birds), 500 authors/researchers, 500 websites, and 100 isotope labs from throughout the world. The database was populated based on extensive library and Internet searches. Users can conduct searches for specific pieces of information (e.g., publications, isotope labs, websites, etc.) or browse sections of the database based on different search fields (e.g., author names, general topics, keywords, geographic areas, isotopes studied, taxa, genus/species, etc.). In addition, the relational nature of the database provides links between different sections. Current versions of the database can be downloaded at <http://fresc.usgs.gov/products/isotope/>.

SELF-OILING IN A COLONY OF LEACH'S STORM-PETRELS IN OREGON: EFFECTS ON SURVIVAL [Poster]

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In this study, we determine effects of self-oiling on survivorship of banded Leach's Storm-Petrels at a breeding colony on Saddle Rock, Oregon (Oregon Islands National Wildlife Refuge). Leach's Storm-Petrels tend to regurgitate when caught in mist-nets, most likely as a predation defense. Some netted birds become covered in the oily regurgitant, leading us to wonder if this self-oiling could be analogous to oiling by petroleum products, thus negatively affecting survival. Survival was assumed if the birds were recaptured on subsequent dates or in subsequent years. To determine if self-oiling affects Leach's Storm-Petrel survival, we assigned each captured bird to one of four categories of percentage self-oiling (0%, 0–5%, 5–20%, >20% total body oiled) in

the years 1990, 1993–1997, and 2004 while mist-netting at Saddle Rock. Our results indicate that some birds are capable of surviving even heavy oiling events.

BEHAVIOUR ANALYSIS OF SEABIRDS AT SEA: A TOOL TO REVEAL HABITAT USE

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Seabird distribution in the southeastern North Sea, the German Bight, has been studied intensively since the 1990s by applying internationally standardized recording methods. To locate areas of special relevance for seabirds, behavioral observations were carried out since 2001. As a case study, the behavior of Lesser Black-backed Gulls (*Larus fuscus*) and Little Gulls (*Larus minutus*) was analyzed with regard to spatial patterns. For the widespread Lesser Black-backed Gull, coastal waters were found to be important for the intake of "natural" food, whereas the offshore region was characterized by the use of fishery waste. Close to the coast, strong temporal and spatial relationships between the behavior of *Larus fuscus* and its major prey, swimming crabs (*Liocarcinus spp.*), could be stated. During the spring migration of Little Gulls, behavioral analysis revealed a distinct flight corridor across the southern German Bight to one of the rivers. This area could be separated from the mouth of the River Elbe and an area close to the offshore island of Helgoland, which were mainly used for feeding. Drowned insects were frequent prey items. In conclusion, behavioral observations of seabirds seem to provide highly valuable information on habitat use and may be well suited for further understanding of distributional patterns of seabirds at sea.

AUKLETS TO MURRELETS: EARLY DISCOVERIES AND SPECULATIONS

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[No abstract was received.]

CASPIAN TERN PREDATION, ENDANGERED SALMONIDS, AND AN UNDEMONSTRATED NEED FOR TERN POPULATION CONTROL

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Federal agencies (Fish and Wildlife Service, Corps of Engineers, NOAA) have proposed reducing the size of the Caspian Tern colony in the Columbia River estuary from >9,000 breeding pairs to circa 2,000 pairs. The agencies claim that the action is "imperative" to benefit threatened Columbia Basin salmon and steelhead. The agencies also argue, though no supporting data are presented, that the action reduces stochastic threats to the tern population and is therefore "in the terns' own best interests." However, independent analyses of the data demonstrate that tern predation is not responsible for salmonid declines and is being used to avoid having to address the factors that actually do significantly influence salmonid populations. Furthermore, data available on stochastic threats demonstrate that not only is there no benefit to the tern colony from its fragmentation and/or relocation, adverse impacts to terns are actually likely to increase.

EXPERIMENTAL TEST THAT FOOD AVAILABILITY LIMITS NESTLING GROWTH IN FORSTER'S TERNS

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A supplemental feeding experiment was conducted on nestling Forster's Terns at Horicon National Wildlife Refuge, Wisconsin, during the summer of 2004 to test the hypothesis that food availability limits growth and survival to fledging. Chicks from randomly-selected nests were given periodic supplements of fish during daily nest visits. The main response variable measured was linear growth rate (LGR), which was the slope of the least-squares regression line for each chick between day 2 and day 13 following hatching. LGR was compared, using analysis of covariance, among nestlings that were supplemented with fish and date-matched controls, with hatch-order as a second categorical predictor variable and hatch date and egg volume as covariates. Only hatch date explained a significant proportion of the variation in LGR of Forster's Tern chicks, and the relationship was negative, meaning that earlier-hatching chicks grew faster than those hatching later, regardless of their hatch order or whether they were provided with additional food. The proportion of nestlings

that survived to fledging age also was statistically equal between the treatment and control groups. These results indicate that Forster's Tern chicks at Horicon were gaining mass at the maximal rate in 2004 and suggest that chronic breeding failure, recorded at Horicon every year since 1999, does not appear to be related to food availability.

GROSS UNDERESTIMATION: THE SORDID TRUTH ABOUT ESTIMATES OF AUKLET ABUNDANCE IN THE BERING SEA

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Least and Crested auklets are the most abundant planktivorous seabirds breeding in the North Pacific. Mixed colonies of these two species number in the millions of breeding pairs, and changes in colony size of these crevice-nesters are difficult to detect. Counts of auklets on the surface of breeding colonies are the most common method used to track changes in auklet numbers; however, this method may greatly underestimate abundance of these two species. We compared two methods for estimating numbers of breeding Least and Crested auklets on St. Lawrence Island, Alaska, in 2004: (1) average maximal surface counts and (2) ratios of individually-marked to unmarked birds on study plots. Estimates of breeding adults from marked:unmarked ratios exceeded average maximal surface counts by an order of magnitude for both species of auklet (7.5–12.3 times and 7.7–15.9 times for Least and Crested auklets, respectively). Abundance estimates of both auklet species from marked-unmarked ratios differed with talus size and depth; Crested Auklet abundance was highest and Least Auklet abundance lowest, in the plot with largest mean talus size. Our results indicate that maximal surface counts grossly underestimate densities of breeding auklets and that nesting density of both species varies with substrate. Abundance estimation using mark-resighting techniques requires considerable effort, but it may be the only accurate method to estimate density of breeding auklets and increase power to detect changes in auklet populations.

FUNCTIONAL ROLE OF CORTICOSTERONE RELEASE DURING FOOD SHORTAGES IN BLACK-LEGGED KITTIWAKES

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Seabirds respond to food shortages by increasing secretion of corticosterone (CORT). This has been proposed as a mechanism allowing seabirds to maximize fitness under varying foraging conditions. We examined short- and long-term consequences of suppressed HPA-axis sensitivity to natural variations in food availability in kittiwakes rearing chicks. We implanted birds subcutaneously with exogenous CORT (experimental individuals) or placebo (controls) for a two-day period and observed their behavior. We measured baseline CORT levels immediately prior to implantation and before implant removal two days later. We found that foraging conditions deteriorated during the two days of the experiment, as reflected in elevated chick begging and changed nest attendance by parents. Controls responded to this temporary food shortage by increasing CORT secretion, whereas baseline levels of CORT remained unchanged in experimental birds. Controls, but not experimental birds, responded to the increase in chick begging by delivering more meals. Three weeks after implant removal, chicks and mates of CORT implanted birds had significantly higher acute stress-induced CORT levels than those from control nests. The next season, the experimental birds and their mates had reduced reproductive success. These results confirm a functional role of HPA-axis activation during food shortages-in chick-rearing kittiwakes, failure to respond to food shortages by increasing CORT secretion results in compromised physiological condition of mates and current offspring and reduced residual fitness.

POPULATION TRENDS OF NORTH PACIFIC ALBATROSSES FROM 1976 TO THE PRESENT

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All North Pacific albatrosses are listed as threatened by the IUCN; therefore, detection of changes in their populations is critical. We analyzed colony surveys of these species across their range for the period of 1976 to the present. The population of Short-tailed Albatrosses (*Phoebastria albatrus*) currently consists of 2,000 birds, is distributed between the Senkaku and Torishima breeding colonies, and is growing at 7.5%/year. The Black-footed Albatross (*P. nigripes*) population contains 290,000 birds, with 95% of the pairs nesting in Hawaii and the remainder on Japanese islands. In Hawaii, Black-footed Albatross populations appear to be declining slightly, while, on Torishima, the population is growing at 8.5%/year. The Laysan Albatross (*P. immutabilis*) population consists of 3.1 million birds, nests primarily in the Hawaiian Islands, and appears to be increasing slightly. We project population changes for all three albatross species under several scenarios of age-specific survival and fecundity.

PROTECTING PENGUINS WITH CREATIVE OCEAN ZONING IN THE SW ATLANTIC

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Less than 0.5% of the oceans are protected (compared with 11.5% of the Earth's land surface), and the status of many marine species continues to deteriorate. Strong political and economic forces oppose the creation of protected areas that would restrict exploitation of marine resources. In the SW Atlantic, human activities such as fishing, shipping, oil exploration and transport, and pollution are putting increasing pressure on marine ecosystems. Most Magellanic Penguins migrate north from their colonies along the Atlantic coast during the austral winter, following a "highway" along the coast from May to July. We document that few marine areas around Magellanic Penguin breeding colonies are currently protected and that the penguin migration route has no protection. Because the birds remain for the most part inside the exclusive economic zone (EEZ) of coastal nations, penguin protection can be implemented at a national level. We propose the designation of a national park with temporal zones to protect penguins and their prey sources during migration and wintering. This novel approach of having a spatial and temporal protected area for a few months of the year could minimize conflicts between people and penguins, with little impact on human economic activities.

WHERE TO FISH? FORAGING ECOLOGY AND HABITAT USE OF JUAN FERNANDEZ PETRELS DURING CHICK REARING

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During chick-rearing, long-lived pelagic birds must balance adult body condition against the flow of energy to chicks. Some groups, in particular procellariiforms, use alternating short- and long-duration trips to meet these demands. I am interested in the linkages between adult behaviours, the use of oceanic habitats, and ultimately, chick growth or survival. Using a combination of data from bird-borne archival data loggers, remotely sensed (satellite) data, and colony studies during early and late chick rearing, I am studying the foraging ecology of Juan Fernández Petrels (*Pterodroma externa*), an endemic seabird of the Robinson Crusoe Islands, Chile. In 2004, foraging trips lasted between 1 and 18 days (mean 4.1; $n = 87$ trips), with both short (1–3 d) and long (4–18 d) trips observed in marked birds. One-third of all chicks were fed on any given night, and individually marked adults ($n = 53$) made 1 to 3 provisioning trips ($n = 24$ nights; 18 Feb–13 Mar). Adults traveled to oceanic habitats characterised by minimal sea-surface temperatures ranging from 10° to 20°C ($n = 16$ trips), placing them in the Subtropical Zone, coastal-upwelling areas (Humboldt Current), or Subantarctic Zone. Cold water masses (<15°C) were only visited by birds during long duration trips (10–17 d). This study provides some evidence for alternating trips in Juan Fernández Petrels and that breeders may use different oceanic habitats to feed themselves and their chicks.

DISTRIBUTION AND HABITAT USE OF COMMON MERGANSERS ON A RESERVOIR IN THE COLUMBIA RIVER

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Alteration of rivers for hydroelectric power and road stabilization creates fragmented landscapes with substantial changes to shoreline and littoral habitats. Fish communities, and fish predators, can be affected by these changes, as fish are potentially concentrated in novel habitats. The Common Merganser (*Mergus merganser*) is a large, fish-eating duck that breeds throughout North America and is known to consume substantial quantities of salmon. In this study, we are investigating the spatio-temporal relationship between shoreline habitats, juvenile salmon, and merganser distribution and behaviour in the mid-Columbia River. In 2003–2004, we conducted weekly abundance surveys and focal-animal samples on the Rocky Reach reservoir during the breeding season. Available habitat was mapped from upland (+100 m) to littoral zones (–10 m), and spatio-temporal patterns in distribution and abundance of birds were established with GIS. Water levels, human disturbance, and fish density were measured as additional factors affecting bird use of habitat. Mergansers foraged more than expected among riprap/rock dominated habitats, areas thought to be attractive to juvenile chinook salmon. Adult females with chicks occupied habitats more typical of undisturbed riverine ecosystems. All birds demonstrated a high level of site fidelity to loafing and foraging sites in proximity to each other. This analysis indicates that altered habitats can change merganser distributions by creating favourable conditions, at least for foraging.

BLACK-FOOTED ALBATROSS: QUANTIFYING BYCATCH IN CANADA'S PACIFIC LONGLINE FISHERIES [Poster]

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Until recently, little was known about bycatch levels in longline fisheries in Canada—information necessary to develop a National Plan of Action and investigate the need for mitigation measures. The Black-footed Albatross, *Phoebastria nigripes*, is the most commonly reported species caught in major commercial longline fisheries in Canada's Pacific. Conservation concern for this species increased in recent years because of projected declines at Hawaiian colonies. We used fishing effort and observer data (2000–2002), salvaged bird data, and a 20-year pelagic seabird database (1982–2001) to estimate bycatch rates and total mortality. We then developed a stochastic, density-independent matrix population projection model to assess population-level effects, assuming affected demographic data from North Hawaiian Islands colonies. Spatio-temporally explicit bycatch rates ranged from 0 to 0.14 birds per 1,000 hooks, with annual estimates of 58–223 albatrosses killed. The birds salvaged from the fisheries were almost entirely non-adults (92%; $n = 13$). Albatross mortality was highest along the continental shelf break, Jun–Aug, when bird aggregations and fishing effort overlap was highest. Although model results indicate no change in albatross survival or population growth when Canadian mortality was removed, this study indicates that Black-footed Albatrosses are vulnerable to bycatch on Canada's west coast during summer months. We stress the need to complete a National Plan of Action and recommend spatio-temporally explicit mitigation measures to reduce bycatch.

BEACHED-BIRD SURVEYS IN CANADA

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Volunteer Beached Bird Surveys in Canada currently occur in Nova Scotia, on the East Coast, and in British Columbia, on the West Coast. Once a month in winter, volunteers survey beaches at 67 sites in BC and at 28 sites in Nova Scotia. In each survey, volunteers walk a specific stretch of beach, recording numbers of beached birds and examining birds for evidence of oil. The proportion of beached birds found with evidence of oiling appears to be higher in Nova Scotia than in British Columbia. Further data from 2 years of surveys in BC and 3 years of surveys in Nova Scotia will be presented. A potential amendment to the Canadian Environmental Protection Act and the Migratory Birds Convention Act that may extend enforcement and judicial powers

regarding illegal discharges of harmful substances, such as oil, into marine waters, will likely increase interest in current and future Beached Bird Survey data.

PREVENTING RAT INTRODUCTIONS TO THE PRIBILOF ISLANDS, ALASKA, USA [Poster]

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The Pribilof Islands have about three million seabirds, a million northern fur seals, an endemic shrew, and other wildlife. Rat introduction would greatly reduce wildlife populations. The islands have been inhabited since 1786, and, although, the lack of harbors impeded rodent introduction, house mice became established on St. Paul in 1872. In the early 1990s, harbors were constructed on both St. George and St. Paul islands, and eventual rat introduction seemed a certainty. To keep the Pribilofs rat-free, a prevention program was begun in 1993 based on cooperation with local communities, government, and industry. The program consists of prevention stations, community education, local shipwreck response capabilities, outreach to make ships rat-free, and regulations. Over a million trap-nights have passed, and six rats have been killed on the St. Paul docks, but no rats have become established. Improved design of stations has decreased maintenance needs. Snap traps have been more effective than poisons but have caused some non-target loss (winter wrens). Local communities are taking increasing ownership in the program, and it appears that fewer ships using the Pribilof Islands carry rats. Without major advancements in rodent-removal technology, the prevention program will have to continue forever. It is too early to be certain that the program is adequate, but, as each rat-free year passes, hopes are rising.

PREVENTING RAT SPILLS ON ALASKA MARITIME NATIONAL WILDLIFE REFUGE: A PRELIMINARY APPROACH [Poster]

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Shipwrecks have caused rodent introductions world wide and continue to be a threat. The first documented rat introduction on Alaska Maritime NWR occurred in 1780, when a Japanese ship went aground on what would later be renamed Rat Island. The Alaska Maritime NWR is responsible for conserving the unique ecosystems and biodiversity of about 3.5 million acres. Prevention of further introductions is of primary concern and is a cornerstone of our invasive-species program. Stopping introductions is both more ecologically effective and cost-efficient. The Refuge established a shipwreck response team in 1995 in an effort to protect over 2,000 islands, rocks, and spires spread across 2,500 miles of the Great Circle trade route from rodent introductions. To date, many incidents involving ships in distress have occurred, though actual field responses have been limited to four. Fortunately, none of these ship casualties had rats. Efforts are now underway to improve response capabilities, expand partnerships, and enlarge the area for which rat spill response is possible. Questions remain about the most effective ways to stop rat invasions from shipwrecks, including appropriate rodenticides and other methods of killing rats, delivery methods, and relevant rat behavior before and after they leave wrecks.

SPATIALLY VARIABLE DENSITIES OF FORAGE-FISH AGGREGATIONS IN AN ALASKAN SUBARCTIC ESTUARY

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We examined the composition and spatial distribution of forage-fish communities in lower Cook Inlet, Alaska, where they are potential prey for seabirds. Acoustic transects and mid-water trawls were used to measure variability in species-specific fish densities and school areas among five oceanographically distinct subareas. Trawl catches were dominated numerically by Pacific sand lance, Pacific herring, and walleye pollock. Sand lance schools were significantly smaller and more dense than schools of other species, peaking at >1,000 m² and >120 fish m⁻² in waters that were warm and shallow with intermediate salinity. Age-0 pollock

schools were the largest and most dispersed, peaking at $>8,000 \text{ m}^2$ and $>15 \text{ fish m}^{-2}$ in waters that were cold, deep, and high-salinity. Sand lance and capelin showed flexibility in school characters, displaying increased density under presumably good conditions and dispersing under poor conditions. Pollock schools were consistent in both density and size, no matter where they were located. The lowest fish densities were measured in the subarea with high turbidity, where schools were both small and diffuse, regardless of species. Spatial variability in fish density paralleled differences in physical oceanography, especially turbidity, and in chlorophyll standing stocks, supporting the concept of "bottom-up control." Differences in prey characteristics among subareas are interpreted as potential differences in energetic returns for foraging predators.

SEX-SPECIFIC SURVIVAL RATES OF ADULT ROSEATE TERNS: ARE MALES PAYING A HIGHER REPRODUCTIVE COST THAN FEMALES? [Poster]

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A long-term mark-recapture/resighting program has been carried out on the Roseate Terns (*Sterna dougallii*) nesting at Falkner Island, Connecticut, USA, from the late 1980s through the mid-2000s. From 1995–1998, an intensive collaborative study of food-provisioning of chicks by their parents also was conducted on many of the banded individuals at this site. Adult female Roseate Terns have significantly higher "local survival" rates than do males. While both sexes feed their young, males usually have higher prey delivery rates than do females and do most feeding of the (oldest if more than one) chick just before it fledges. Successful male parents usually depart at the same time as the (oldest) fledgling, while female parents may linger at the colony site for up to two weeks. The lower "local survival" rate of males probably does not represent lower colony-site fidelity, but instead may reflect the cost they bear for doing more parental care, especially if fledglings are still dependent on them for food during post-breeding dispersal and (at least early) migration to their wintering areas.

FACTORS AFFECTING THE MOVEMENT OF SEMIPALMATED SANDPIPERS (*Caldris pusilla*) MIGRATING THROUGH THE UPPER BAY OF FUNDY

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The upper Bay of Fundy is a critical migratory stopover point for Semipalmated Sandpipers, with an estimated 1 to 2 million birds annually visiting local mudflats to feed on the energy-rich amphipod *Corophium volutator*. Little is known about how these birds select foraging and roosting sites and if they stay on single mudflats or move within the region during their approximate 2-week stay. Such knowledge is important from a conservation standpoint, in that understanding bird movements will help to obtain more accurate population estimates and monitor population declines. Also, the ability to use multiple mudflats should reflect birds' capacity to adapt to human induced changes to mudflats, such as the damming of tidal rivers. We hypothesize the main factors that could potentially influence sandpiper movements and habitat use are: (1) abundance of *C. volutator*; (2) predation threats by raptors; and (3) landscape. To assess movements and test the importance of these factors, 40 sandpipers from two areas of the Bay of Fundy were radio-tracked during the summer of 2004. The birds were found to use multiple foraging and roosting sites. Preliminary results suggest that these movements are not strongly correlated with any one factor, but the birds are weighing a combination of all the factors when selecting a site.

MONITORING AND EVALUATION OF AVIAN PREDATION ON JUVENILE SALMONIDS ON THE YAKIMA RIVER, WASHINGTON, ANNUAL REPORT 2003

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Avian predation contributes to the loss of migrating juvenile salmonids in the Yakima River Basin, constraining natural and artificial production. In 1997, the Yakima/Klickitat Fisheries Project (YKFP) assessed the feasibility of developing an index to avian predation of juvenile salmonids. The initial research confirmed

that gulls and Common Mergansers were the primary avian predators impacting migrating smolts (Phinney et al. 1998). From 1999 to 2002, the Cooperative Fish and Wildlife Research Unit (WACFWRU) continued monitoring the impacts to juvenile salmonids along river reaches and at areas of high predator/prey concentrations (hotspots). The YKFP, Yakama Nation Fisheries, began monitoring avian predation in 2002, and continued monitoring in 2003 and 2004, at hotspots and along river reaches. Consumption by gulls at hotspots was based on direct observations of foraging success and modeled abundance. Consumption by all piscivorous birds on river reaches was estimated from published dietary requirements and modeled abundance. 2003 saw a shift in predator species at one of the hotspots from gulls to American White Pelicans. Gulls remained the primary predatory at the other hotspot. American White Pelicans were the major consumer on the lower river, and Common Mergansers remained the primary consumer on the upper river. Estimated consumption by gulls at both hotspots in the spring was 141,349 fish. Consumption by Common Mergansers accounted for 82% of consumption in the upper river.

PIPING PLOVER RECOVERY IN THE GREAT LAKES 1985–2004: A PROGRESS REPORT [Poster]

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The Great Lakes population of Piping Plovers (PIPL) was listed as federally endangered under the U.S. Endangered Species Act in 1986. Historically, PIPLs nested throughout the Great Lakes (estimated population 500–800 pairs) but declined to 11–14 pairs, all within the state of Michigan, by the mid-1980s. As of 2004, the breeding population is 55 nesting pairs. Although the breeding population more than doubled in the last 15 years, only two known breeding sites are outside of Michigan. Recovery efforts have included intensive nest monitoring and protection via a network of cooperators (MI-DNR, WI-DNR, NPS, USFWS, USFS, U of MN and NGOs). Additionally, monitoring off the breeding grounds via intentional and opportunistic observations have provided information on movements of banded individuals during the winter. Despite a population increase, Piping Plovers are still extremely vulnerable to extinction from predation, demographic and environmental stochasticity, and continued beach development. Continued coordination with partners in protection efforts is required to reach recovery.

WING LOADING AND PREVAILING WINDS: THEIR RELATIVE IMPORTANCE TO THE AT-SEA DISTRIBUTION OF FOUR SPECIES OF PACIFIC ALBATROSSES. [Poster]

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The four species of albatrosses that inhabit the central and North Pacific Ocean exhibit markedly different distributions at-sea. The two species that nest relatively close (500–1,500 km) to highly productive continental shelf regions, the Short-tailed (*Phoebastria albatrus*) and Waved albatrosses (*Phoebastria irrorata*), are larger than the two species that nest farthest (>3,000 km) from productive continental margins, the Laysan (*Phoebastria immutabilis*) and Black-footed albatrosses (*Phoebastria nigripes*). These morphometric disparities indicate potential significance of body size and flight energetics. We obtained measurements of body and wing morphologies pertinent to flight performance from the four species of albatrosses and obtained global monthly sea surface wind speeds from Quikscat scatterometers (1999–2004). Our results indicate that wing loading (body weight/wing surface area) varies up to 30% among species, resulting in up to 20% differences in minimal sink and best glide velocities. Interspecies differences in flight morphologies appear consistent with average wind speeds within respective foraging ranges.

FACTORS INFLUENCING THE RELEASABILITY OF PELICANS AFFECTED BY BOTULISM AT THE SALTON SEA [Poster]

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Rehabilitation efforts for pelicans suffering from botulism intoxication have been conducted at the Salton Sea National Wildlife Refuge (SSNWR) and cooperative wildlife rehabilitation facilities since an epidemic event of Type C avian botulism affected numerous American White Pelicans (*Pelecanus erythrorhynchos*) and California Brown Pelicans (*P. occidentalis californicus*) in 1996. We evaluated the correlation between the releasability of botulism-affected pelicans and a variety of clinical signs and biomedical factors that may affect success of the rehabilitation process to establish a prediction model. Pelicans sickened by botulism were classified into different stages based on severity of clinical conditions (stage 1: critical; stage 4: non-critical). An integrated prediction model revealed that pelicans were 3.1 times and 5.0 times more likely to be released with successive stage increases from the SSNWR and rehabilitation centers, respectively. The releasability of antitoxin treated birds was 2.9 times higher than that of birds that did not receive antitoxin. Pelicans that presented with severe dehydration and secondary eye lesions upon intake were less likely to be released than those that did not have these clinical conditions. Blood chemistry analyses revealed significantly decreased levels of enzymes related to muscle damage and increased carbon dioxide levels in botulism-affected pelicans upon intake compared with those of the same individuals on pre-release examination.

NEW ORNITHOLOGICAL OBSERVATIONS AND SEABIRD COLONY RESTORATION PLANNING ON LEHUA ISLET, HAWAII [Poster]

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Recent surveys of Lehua Islet, Hawaii, found new nesting seabird species and significant changes in abundance of previously recorded species. Surveys documented over 25,000 breeding pairs of eight seabird species, including previously unknown breeding colonies of Black-footed Albatross (*Phoebastria nigripes*) and Laysan Albatross (*P. immutabilis*). Four additional species are suspected of breeding in small numbers, including the threatened Newell's Shearwater (*Puffinus auricularus newelli*), endangered Hawaiian Petrel (*Pterodroma sandwichensis*), and Band-rumped Storm Petrel (*Oceanodroma castro*), a candidate for listing. However, two invasive alien species, Polynesian Rats (*Rattus exulans*) and European Rabbits (*Oryctolagus cuniculus*), have been present on Lehua since at least the 1930s. Negative impacts of these species on seabirds and native plant populations have been documented on Lehua and other Hawaiian islands. Predation by introduced Barn Owls (*Tyto alba*) on seabirds was also documented on Lehua. Plans and permitting for rat and rabbit eradication are underway. Proposed restoration techniques include two methods never tried before on Hawaiian seabird islands: use of hunting dogs trained to work in seabird colonies, followed by aerial application of rodenticides. Rat and rabbit eradication will allow natural recolonization of Lehua by a variety of rare and threatened seabird and plant species. Natural recolonization may be supplemented by reintroductions of additional rare species.

WINGS, FINS, AND THE BLACK BOX: ECOSYSTEM-BASED FISHERIES MANAGEMENT USING SEABIRDS

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Factors affecting the oceanic life stage of many fish are not well known. In this study, we test the hypothesis that marine birds, as near-real-time indicators of biological productivity of lower trophic-level marine organisms, provide a means of quantifying variable oceanographic conditions and prey availability to juvenile and/or adult fish during their time at sea. In particular, some seabirds (e.g., auklets, murre, and some gulls) have very similar diets to herring and salmon. Therefore, these birds may serve as useful indicators of ocean foraging conditions for planktivorous fish in the North Pacific Ocean. As an example, we report how multidecadal (1971–2002) studies of seabird productivity and food habits from Southeast Farallon Island,

California (42 km west of San Francisco) can promote understanding of spawning biomass and body condition for San Francisco Bay herring and recruitment rates for Central Valley chinook salmon. We also report how diet data from 3 species of seabirds, in combination with NMFS pelagic juvenile-rockfish trawls and salmon gut contents, can be used to develop a multivariate index of interannual to interdecadal variability in juvenile rockfish (*Sebastes* spp.) abundance. This non-traditional information for assessing feeding conditions may provide novel perspectives on the ecological factors affecting survival of fish during the “black box” of their life cycle, and thereby contribute to fisheries management.

MODELING BLACK-BROWED ALBATROSS IN WINDY HABITATS: TOWARDS RESOURCE-SELECTION FUNCTIONS AND DISCRETE-CHOICE MODELS IN CONSTANTLY CHANGING ENVIRONMENTS

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Black-browed Albatrosses (*Diomedea melanophrys*) live under extreme conditions. During the breeding season, they fly great distances, but their pelagic habitat preferences are mostly unknown. Here, we present a progressive quantitative habitat analysis for the 1996–1997 Austral summer incubation period. Locations over the Patagonian Shelf off of Argentina were obtained using Global Location System (GLS) Data Loggers. Location data were overlaid in a GIS (Geographic Information System) with scatterometer wind fields from both Special Sensor Microwave Imager (SSM/I) satellites and the NSCAT instrument carried on the NASA/NASDA ADEOS satellite. The wind measurements (wind speed and wind direction) were taken twice daily. We built Resource Selection Functions for this constantly changing habitat to explain in a quantitative fashion where albatrosses fly during incubation and to model and predict these foraging flights unique in the animal kingdom. Distinct patterns were found in the habitat coefficients helping us to understand where and how these animals fly and forage in the open ocean hundreds of kilometers away from land. Finally, we elaborate on how these findings can be used for building powerful Discrete Choice Models of foraging albatrosses.

NOVEL MICROSATELLITE MARKERS USED TO DETERMINE THE POPULATION GENETIC STRUCTURE OF THE ENDANGERED ROSEATE TERN IN NORTHWEST ATLANTIC AND WESTERN AUSTRALIA

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The Roseate Tern (*Sterna dougallii*) is an endangered species in the Northwest Atlantic, where it has been plagued by population bottlenecks over the past 120 years. This population has been slow to regain former size and range, perhaps in part due to the female-biased sex ratio, which results in female-female pairs, reducing the average productivity of the colony. The larger populations of the Western Pacific and Indian Oceans are not endangered, and there is no evidence of a biased sex ratio at breeding colonies in Western Australia. We developed four novel microsatellite markers and adapted one other, and these are the first used in the genus *Sterna*. We also determined the utility of these markers for 17 related species. Here, we report the population genetic structure within and between two regions, the Northwest Atlantic and Western Australia. A significant finding is that the Northwestern Atlantic region has much lower allelic diversity than the Western Australia region, promoting the recommendation for increased protection of sites in this region to preserve remaining genetic diversity and new potential breeding habitats.

INFLUENCE OF LANDSCAPE CONTEXT AND LOCAL WETLAND FOOD ABUNDANCE ON WINTERING SHOREBIRDS IN AN AGRICULTURAL VALLEY

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While it is generally understood that the local abundance of benthic invertebrates can greatly influence site use by wetland birds, how the availability of surrounding wetland habitat (landscape context) may mediate this relationship is unknown. We studied the influence of wetland food abundance and landscape context on use of agricultural wetlands by wintering Dunlins (*Calidris alpina*) and Killdeer (*Charadrius vociferus*) in the Willamette Valley of Oregon, USA, over two winters (1999–2000, 2000–2001) of differing rainfall and subsequent habitat availability. We monitored bird use (frequency of occurrence, abundance) at a sample of wetlands differing in local food abundance (density and biomass) and landscape context (i.e., adjacent shorebird habitat within 2-km radius, nearest-neighbor distance) and evaluated predictive models using the Cp criterion. During the dry winter (2000–2001), Dunlins exhibited greater use of sites with higher invertebrate density and biomass, more adjacent shorebird habitat, and closest to a wetland neighbor. Sites use by Killdeer were unrelated to either local food abundance or landscape context measures during both winters. Our results call for a more strategic conservation planning approach for wetland landscapes that considers the spatial location and context of focal sites before focusing on the local management practices that can be used to enhance invertebrates.

THERMOCLINE SHAPES DIVING BEHAVIOR OF THICK-BILLED MURRES [Poster]

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Linking diving and foraging behavior of small seabirds with fine-scale characteristics of water masses has been challenging largely due to technological constraints. We examined the diving behavior of 12 chick-rearing Thick-billed Murres at St. George Island, Eastern Bering Sea, in relation to sea-surface temperature (SST) and thermocline depth that were recorded by ventrally-attached depth-temperature-acceleration data loggers (16 g). Our initial results from summer 2004 showed that murres utilized various water masses, ranging from well-mixed water (SST 7–9°C, near the island) to well-stratified water (SST 9–12°C, far from the island). Murres dived deeper (modal depth 70–80m) in the mixed water mass, whereas dives were shallower (modal depth 20–30m) and to just below the thermocline depth in the stratified water mass. In the stratified water mass, murres dived deeper, to below the thermocline, during the last dive bout in a foraging trip, when they were presumably foraging for a chick meal rather than foraging for themselves. We suggest that the thermocline is important in shaping depth utilization of Thick-billed Murres, possibly through its effect on the vertical distribution of both zooplankton and fish prey.

USING PHYSIOLOGY TO PREDICT STAGING BEHAVIOR OF POST-BREEDING SHOREBIRDS ON ALASKA'S NORTH SLOPE [Poster]

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Arctic-breeding shorebirds are known to stage in coastal littoral zones, where they acquire fat reserves necessary to migrate to wintering areas. The length of time shorebirds remain at a staging area may be affected by the quality of the site (e.g., food quality and availability, predator density). We captured, marked, and blood-sampled shorebirds staging in Barrow, Alaska, in August 2004 to examine relationships among tenure time (length of an individual's stay at a particular site), fattening rate (plasma levels of triglyceride and glycerol), and

corticosterone level. We related the physiological parameters to minimal tenure times of individually marked/radio-equipped shorebirds. We predicted that birds exhibiting high fattening rates should remain at a staging site for a shorter period of time. We also predicted tenure times should reflect variations in migration strategy and, therefore, physiology among species. Preliminary analyses of Semipalmated Sandpipers, Red Phalaropes, Western Sandpipers, and Dunlins sampled at Barrow support the first prediction, but additional data are needed to address the second. We discuss how a large-scale spatial study that includes sampling shorebirds at five major staging sites across the North Slope of Alaska in 2005 will allow us to address additional hypotheses relating to staging behavior, site quality, and physiology.

A CITIZEN SCIENCE EFFORT TO SURVEY SOUTHBOUND SHOREBIRDS IN NEW JERSEY: RESULTS OF A FIRST YEAR STUDY [Poster]

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New Jersey Audubon Society, together with the NJ Endangered and Nongame Species Program, coordinated a coast-wide survey of southbound migrant shorebirds that was carried out by Citizen Scientists during the summer and fall of 2004. This fall migration survey, whose purpose is to assess the status and monitor shorebird populations in New Jersey, ties into similar national efforts, such as the International Shorebird Survey (ISS) and the “Program for Regional and International Shorebird Monitoring” (PRISM). Citizen science volunteers were trained in shorebird identification and count methodology. Almost all of the 30 volunteers who attended the training sessions subsequently signed up to conduct counts at approximately 25 sites total along the NJ coast. Counts were conducted from mid-July until the end of October. The results of this first coast-wide study show that sites in Southern New Jersey and mainly along the Atlantic coast and barrier beaches support significant numbers of shorebirds (in the thousands to tens of thousands). This pilot project can serve as a model for future similar projects employing the help of interested citizens.

LESSONS LEARNED FROM A COMPREHENSIVE LITERATURE REVIEW AND DEVELOPMENT OF A DATABASE ON CONTAMINANTS IN ARCTIC SEABIRDS [Poster]

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The Arctic Seabird Contaminant Database and Annotated Bibliography (ASCODAB) is a searchable database that has been created for 39 seabird species and contains over 400 articles with tables containing contaminant information entered into ASCODAB. While other public contaminant databases only give the ability to view concentrations for one datum or data set at a time, ASCODAB allows one to view all the data points or search for data based on criteria such as date, location, species, and contaminant type and export the results to Microsoft Excel for additional analyses. Canada and northwestern Europe have conducted the most work on Arctic seabirds. Eggs, liver, and muscle tissues have been examined the most for contaminants. ΣPCBs, mercury, and DDE are the primary contaminants reported. The major hurdle to using ASCODAB to perform time-trend analysis is the lack of reporting lipid and moisture content values for the analyzed tissue. Reporting percentages of these variables would allow “back of the envelope” calculations for converting wet, dry, and lipid weight measurements. While the database allows these types of comparisons to be made easily, care must be taken when examining the quality of the data. Different methods, quality assurance, and reporting measures all can affect the results.

USING REMOVE VIDEO SURVEILLANCE TO DETERMINE CAUSE OF DESERTION OF AN URBAN HERONRY

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As the trend toward urbanization progresses in the Twin Cities metro area, individual colony sites are becoming increasingly important to local populations of colonial waterbirds. The Peltier Lake Great Blue Heron colony, once about 600 pairs, has decreased to 100–200 pairs, and no young have fledged for 5 years due to premature nest abandonment by the adults. Herons continue to attempt to nest at this location. The Minnesota Department of Natural Resources initiated a study to determine possible causes of mortality at Peltier Lake in summer 2005. The control site was at Pig's Eye Lake, a nearby mixed-species colony. In addition to bimonthly aerial surveys and weekly ground surveys, 12 nests were monitored using treetop video cameras. Multiple channels of time-lapse video were recorded through digital multiplexers onto Sony T-120 tapes. Power was supplied with 12-V deep-cycle batteries. Disturbance, chick mortality, and the rapid collapse of the Peltier Lake rookery were documented. Raccoons appeared to be an important cause of chick mortality at Peltier Lake, while stochastic events and siblicidal aggression appeared to be more important at Pig's Eye Lake. Normal productivity was recorded at Pig's Eye Lake, and the Peltier Lake colony produced no fledged young. Use of remote cameras enabled abundant data collection with relative ease and minimal expense and disturbance in the colonies. This method is also applicable for other tree-nesting colonial species as well as for behavioral studies.

THE FAT THICKENS: MORE ON FATTY-ACID SIGNATURES OF NORTHERN FULMARS IN ALASKA

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Seabirds are sensitive indicators of changes in the marine ecosystem, responding to fluctuations in prey availability by changing their diet. Quantifying the relative importance of various prey species through diet studies can further our understanding of marine food webs and ecosystem dynamics. Traditional methods of diet sampling suffer from well-known disadvantages. Fatty-acid signature analysis is an accurate, non-lethal method that has been successfully applied to infer the diets of marine mammals and seabirds. We analyzed fatty acid signatures in adult fulmars (*Fulmarus glacialis*) during 2003 and 2004 from two different colonies in Alaska. Fulmars possess two lipid sources: adipose tissue and stomach oil. Stomach oils are lipid-enriched dietary residues composed of a variety of lipids, while the fatty-acid composition of adipose tissue is primarily influenced by diet but also consists of certain fatty acids that can be biosynthesized by animals. We collected stomach oils and adipose tissue samples from birds at St. George Island to test the hypothesis that signatures of two sources of lipid from the same individual are different. We also compared signatures in adipose tissue from birds sampled at Chowiet Island in May and August 2003, birds sampled at St. George in June 2003 and 2004, and birds at Chowiet and St. George during 2003 and 2004. We found that signatures from the two lipid-source birds are significantly different. We also found significant intra-annual variation in signatures on Chowiet in 2003, inter-annual variation at Chowiet and St. George, and differences between colonies in both years.

BODY ANGLE, SWIM SPEED AND REGULATION OF STROKE IN WING-PROPELLING DIVERS: A COMPARISON AMONG ALCID AND A PENGUIN

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Diving seabirds experience large buoyancy and drag. These physical constraints and foraging patterns vary greatly among alcid and penguins. We collected data on body angle, swim speed, and wing stroke of free-

ranging Thick-billed Murres, Common Murres, Rhinoceros Auklets, Razorbills, and Little Penguins. Acceleration and depth were sampled at 32 or 64 Hz and 1 Hz, respectively, using data-loggers. Low- and high-frequency components of acceleration provided estimates of body angle and wing stroke, respectively. Swim speed was estimated using body angle and depth change rate. Thick-billed and Common murres made vertical dives, but dives of the other three species were oblique. Swim speed during descent was higher for Little Penguins than murres and Razorbills, with Rhinoceros Auklets having the lowest swim speed. During passive ascent, alcids increased body angle and swim speed. In contrast, Little Penguins decreased body angle whilst maintained high swim speed. During descent, Little Penguins made forward thrusts on both the up- and down-stroke, irrespective of dive depth. Thick-billed Murres, Common Murres, and Rhinoceros Auklets made forward thrusts on both the up- and down-stroke in shallow depths but only on the down-stroke in deep depths. There was a smaller range of surge acceleration associated with strokes in Little Penguins than alcids, indicating that penguins swim more steadily.

DIET SHIFT IN HEERMANN'S GULLS (*Larus heermanni*) DURING THE NON-BREEDING SEASON [Poster]

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Heermann's Gulls breed in the Sea of Cortez during during March–May. After breeding, they disperse to the Pacific coast, where they congregate on sandy beaches and molt their flight feathers. During June–September of 2003–2004, I examined the diet of Heermann's Gulls along the central coast of California by collecting regurgitated pellets from individuals on Guadalupe Beach in San Luis Obispo County. Each pellet was cleaned and prey remains identified. The majority of 200+ pellets examined consisted solely of shell remains of mole crabs (*Emerita analoga*). This diet preference has not been recorded for this species previously, but it is known for the closely related Gray Gull (*Larus modestus*) of South America. In contrast to the Gray Gull, Heermann's Gulls appear to only feed on mole crabs during the non-breeding season. I believe this difference is due to the energetic cost of the Heermann's Gull's preferred surface-dipping and surface-plunging feeding habits. The post-breeding molt reduces their ability to forage effectively offshore, thereby limiting them to less energetically costly feeding techniques. Indirect evidence for this conclusion comes from the lack of juvenile Heermann's Gulls observed feeding on mole crabs during the summer months. Because juveniles do not molt their flight feathers during their first year, they are not limited in their foraging ability, and, hence, are the age-group most commonly encountered offshore during June–September.

DETECTION PROBABILITIES WHEN COUNTING RING-BILLED GULL NESTS ON THE GREAT LAKES [Poster]

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Nest counts were made at four Ring-billed Gull colonies on the lower Great Lakes in 1999 and 2004 for the purpose calculating repeatability and detection probability (DP). Forty-two strip transects 5–8 m wide were traversed by single researchers, and all gull nests within each transect were counted. On reaching the end of the strip, the researcher turned around and recounted the nests walking in the other direction. Strips contained 32–303 nests (mean = 99.3). Second counts ranged from 21.7% more than to 11.1% less than the first count; the mean was 3.0% more than the first count, and 88.1% of the second transect counts were within 5% of the first counts. Detection probability was calculated for 20 of the 42 strips by having 1–2 researchers follow the initial single counter and paint all nests in the strip; this figure became the “true” number of nests. Detection probabilities for individual strips ranged from 81.7–100%, the mean was 94.9%, and 55.0% of counts had a DP of 95% or greater; 90.0% of counts had a DP of 90% or greater. These repeatabilities and detection probabilities should be comparable for ground-nesting colonial species with minimal ground cover, e.g. Ring-billed, Herring and California Gulls, as well as Double-crested Cormorants, and indicate a high degree of accuracy for these species in past Great Lakes surveys.

CONSTRUCTED NESTING ISLANDS FOR COLONIAL WATERBIRDS IN HAMILTON HARBOUR, LAKE ONTARIO

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Hamilton Harbour, at the western end of Lake Ontario, is one of the most important nesting areas on the Great Lakes for colonial waterbirds. Of the waterbirds nesting on Lake Ontario, approximately 11% nest there; it is particularly important for Caspian and Common terns, since 20% and 50%, respectively, of Lake Ontario's nesting populations are found there. During the winter of 1995/1996, three islands were constructed in the Harbour, since one of the main nesting areas for colonial waterbirds elsewhere in the harbour was slated for development. During construction, island habitats were designed and created to accommodate six species: Double-crested Cormorant, Black-crowned Night-Heron, Herring Gull, Ring-billed Gull, Caspian Tern, and Common Tern. Since construction, management strategies have been employed to maintain biodiversity on the islands. Five of the intended species nested on the islands the first season after construction; the 6th species (Double-crested Cormorant) did so in 1998. Regression analysis showed that, from 1997–2004, the number of Caspian and Common tern nests decreased non-significantly and night-herons and Herring Gulls increased non-significantly. The number of cormorant and Ring-billed Gull nests has increased significantly. The increased number of nesting Ring-billed Gulls has meant that it has become more difficult to maintain habitat available for Common Terns, who must compete with Ring-billed Gulls for nesting areas. Raptors and other methods are being used to maintain tern habitat.

OVERPRODUCTION OF DAUGHTERS BY MOTHERS IN POOR CONDITION IN GALÁPAGOS NAZCA BOOBIES: ADAPTATION OR CONSTRAINT? [Poster]

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Sex-allocation theory predicts that individuals will maximize fitness by adjusting offspring sex ratios in response to their own and environmental conditions. Many examples of biased avian sex ratios exist, but relatively few provide strong support for an adaptive explanation in a wild population. We tested two prominent hypotheses of adaptive sex allocation in the sexually dimorphic (female-larger) Nazca booby (*Sula granti*) using long-term reproductive history data and the sexes of 2,203 hatchlings from two consecutive breeding seasons. Hatchlings were sexed by PCR amplification of an intron region of the CHD gene. Clutch size was used as a proxy for maternal condition, as food-supplementation has been shown to induce females to lay a second egg (maximal clutch size = 2). The overall hatching sex ratio, as well as that from two-egg clutches, was not different from 50:50 in either year. Single-egg clutches, however, were significantly female-biased in both years ($P < 0.001$). We found no support for either the sexual-size-dimorphism hypothesis or the Trivers-Willard hypothesis of adaptive sex-ratio adjustment, which both predict that mothers in poor condition should tend to produce sons. Our results are consistent with male-biased embryonic mortality in low quality mothers, possibly induced by maternal steroid hormones in circulation or *in ovo*.

PREDICTABLE HOTSPOTS FOR THE ENDANGERED SHORT-TAILED ALBATROSS IN ALASKA

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The three North Pacific albatrosses (Laysan, Black-footed, and Short-tailed) forage widely over the North Pacific basin but are segregated in marine waters of Alaska during summer. Laysan (LAAL) and Black-footed (BFAL) albatrosses occur mostly in pelagic habitats south of the Aleutians and in the Gulf of Alaska (GOA), and they are segregated spatially from east (BFAL) to west (LAAL). Populations of Short-tailed Albatross (STAL) were driven to near extinction during the 1900s, and observations at sea have been very limited until recent years. Because the STAL was historically hunted and eaten by coast-dwelling Aleuts and sometimes found far inshore on continental shelves, it was considered a “coastal” albatross. However, re-analysis of more than 1,100 sight records of about 1,800 birds suggests to us that the STAL concentrates its foraging effort in areas of upwelling along the outer continental shelf-edge in the northern GOA, along the length of the Bering Sea shelf-edge, and along shelf-edges and deep passes in the Aleutian Islands. The species

is only “coastal” where coastlines are close to strong upwelling zones. Because of its association with topographically defined upwelling systems, it appears that some hotspots for STAL are predictable.

NUMBERS OF XANTUS’S MURRELETS WITHIN NOCTURNAL AT-SEA CONGREGATIONS AT BREEDING COLONIES IN SOUTHERN CALIFORNIA AND BAJA CALIFORNIA [Poster]

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In 2000–2004, we used nocturnal spotlight surveys to determine the distribution and number of Xantus's Murrelets (*Synthliboramphus hypoleucus*) attending at-sea congregations beside breeding colonies during the breeding season (March–June). Island surveys were conducted at Anacapa (ANA); Santa Barbara (SBI); San Miguel (SMI); Santa Rosa (SRI); Santa Cruz (SCZ); Santa Catalina (CAT); Los Coronados (COR); and San Benitos (BEN). Three-person crews in inflatable boats traveled along pre-determined GPS transects in nearshore waters (200–500 m from shore) and counted murrelets sitting on the water with high-intensity spotlights. Murrelets were observed at all islands surveyed except SRI, with the highest survey count total recorded at COR in 2002 (1,235 murrelets at four islets combined). Maximal encounter rates (murrelets/km for each island were: 0.3 (SMI); 3.5 (SCZ); 29.4 (ANA); 56.0 (SBI); 1.2 (CAT); 69.8 (COR); and 19.8 (BEN). Largely inaccessible breeding habitats on cliffs or steep slopes make surveys of at-sea congregations the only practical index for assessing colony size and whole-colony population trends. Additional surveys are planned for 2005–2006 at several colonies, including Guadalupe Island, the largest colony for the southern subspecies (*S. h. hypoleucus*).

BREEDING SUCCESS AND NESTING AREAS OF XANTUS'S MURRELETS AT ANACAPA ISLAND, CALIFORNIA, 2000-2004 [Poster]

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In 2000–2004, we monitored 13–26 nests of Xantus’s Murrelet (*Synthliboramphus hypoleucus*) per year in 10 sea caves and other sample areas at Anacapa Island, California. By measuring breeding success, depredation rates, and numbers of nests/cave, nest monitoring has helped to document initial improvements to the murrelet population following eradication of Black Rats (*Rattus rattus*) in fall 2002 with *American Trader* oil spill settlement funds. Hatching success in post-eradication years (2003–2004) was much higher (79%) and nest depredation much lower (8%) than observed in the pre-eradication years (2000–2002; hatching success 42%; nest depredation 42%). Nest failures due to rat depredation were not recorded in 2003–2004, but expanding native Deer Mice (*Peromyscus maniculatus*) populations recovering from rat impacts have resulted in egg depredations at two cave nests in 2004. Numbers of nests in occupied caves increased from just nine in 2000 to 15 in 2003, indicating slow initial population growth based on Anacapa production as expected. However, murrelets have expanded slowly into some accessible non-cave habitats previously occupied by Black Rats. Despite reduced nesting effort (nine sea cave nests) and delayed breeding in 2004, breeding conditions have continued to improve (i.e., hatching success 78%; nest depredation 22%). Further monitoring is planned to help document the process and degree of recovery over time and detect any factors which may speed or impede continued recovery.

INDIVIDUAL MOVEMENTS AND FORAGING RANGES OF RADIO-MARKED XANTUS'S MURRELETS [Poster]

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We used radio telemetry to examine individual movements and foraging ranges of 19 Xantus's Murrelets (*Synthliboramphus hypoleucus*) captured at Santa Barbara Island (SBI), California, in April 1997. At-sea movements were tracked during 37 aerial surveys conducted off the coasts of southern and central California, while murrelets near SBI were detected with a remote receiving station. For these 19 individuals, we recorded 291 locations (mean = 15 ± 6 locations/murrelet) and detected murrelets over periods ranging from 15–51 days (mean = 33 ± 13 d). Total distances traveled by individuals ranged from 266 km over 29 days to 2,227 km over 47 days. Murrelets foraged far (mean = 98 ± 26 km) from SBI during the peak colony attendance period (10 April–15 May). Although none had brood patches when captured, five murrelets returned frequently to SBI and displayed movement patterns consistent with incubation. Frequent returns to SBI resulted in much higher daily rates of travel (i.e., "breeding" birds, mean = 94 ± 34 km/d; "non-breeding" birds, mean = 27 ± 12 km/d). Higher rates of travel by "breeding" birds resulted from extensive flights between SBI and foraging areas, not movements between at-sea locations, which were similar ("breeding" birds, mean = 16 ± 3 km/d; "non-breeding" birds, mean = 15 ± 6 km/d). Foraging trip duration was positively correlated with maximal distance from SBI and total distance traveled.

ADAPTIVE MANAGEMENT OF PREDATOR-PREY LINKAGES: PISCIVOROUS BIRDS AND ENDANGERED SALMON IN THE COLUMBIA RIVER

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Caspian Terns and Double-crested Cormorants have been documented as significant mortality sources to out-migrating salmon smolts in the Columbia River estuary. Whether avian predators negatively impact smolt populations in the mid-Columbia River is currently unknown. We present a quantitative evaluation of the effects of avian predators on out-migrating salmon in the mid-Columbia (Chelan Co.), central Washington, based on diet studies, bioenergetics, and behavioral observations. Although lethal and non-lethal bird control is concentrated at dams, our data indicate that 82–97 % of the predation occurs elsewhere on the river. We estimate that birds in Chelan County currently consume between 45,000–70,000 salmon smolts between April–August, less than 1% of those present above Rock Island dam. Adult Common Mergansers and Ring-billed Gulls are mostly responsible for this predation, although there are significant species-specific differences. Finally, some avian predators may be beneficial to salmonids during certain periods, as gulls and mergansers also consume large numbers of northern pikeminnow, a major predator of juvenile salmonids. We present an adaptive management model that includes running the bioenergetics model backwards and integrates policy set salmon mortality limits. This temporally and spatially explicit approach is more ecologically sound, and ensures the protection of endangered salmon, while not unnecessarily impacting their predators.

EFFECT OF OBSERVER EXPERIENCE AND PRECISION ON THE USE OF A WING KEY FOR MURRES (*Uria* spp.)

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Hundreds of thousands of murres (Thick-billed and Common) are legally hunted along the coasts of Newfoundland and Labrador, Canada. However, the species and age composition of this hunt are currently unmonitored. Furthermore, these two species are routinely found on beached bird surveys after they fall victim to chronic oil pollution at sea. As a step toward implementing a species-composition survey for the hunt and help standardise beached bird surveys, a key was derived to age and differentiate between murres based on wing characteristics; this key has been documented in a previous study. In this study, the use of the key was tested on

inexperienced observers. Observers aged and measured 84 murre wings in duplicate. The ability to age wings correctly improved with experience, reaching rates of 88–96%. Feather measurements incorporated in a discriminant function (DF) yielded correct species-classification rates of 92–96% without prior experience. Despite differences in measurement precision and repeatability between observers, the DF proved to be robust, as shown with the high correct species-classification rates. These results provide the necessary information to implement a reliable key, which in turn will help monitor murre populations vulnerable to these anthropogenic activities.

REMOTE SENSING: FATTY-ACID AND STABLE-ISOTOPE SIGNATURES SUGGEST SEASONAL AND AGE-RELATED VARIABILITY IN TUFTED PUFFIN DIETS

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Fatty-acid signature analysis has been successfully used to estimate diets of free-ranging marine predators qualitatively and quantitatively, whereas analysis of stable isotopes provides information on the trophic position of individuals. We determined fatty acid profiles of adipose tissue sampled from 58 adult and 23 nestling Tufted Puffins (*Fratercula cirrhata*) that were captured during three distinct time periods in 2003: pre-incubation ($n = 15$), late-incubation ($n = 20$), and late chick-rearing ($n = 23$ adults and 23 nestlings). Discriminant analysis of the four groups using the 14 most abundant fatty acids classified individuals into groups with >97% accuracy and indicated that the diet of adults shifted across seasons and differed from that of nestlings during the chick-rearing period. Whole-blood samples from adults ($n = 23$) and nestlings ($n = 23$) captured during the late chick-rearing period were analyzed for stable isotopes of C and N. Blood samples collected from adults had $\delta^{15}\text{N}$ values that were slightly (+0.187‰), but significantly ($P < 0.01$) enriched compared to nestlings. Adult blood was also significantly ($P < 0.01$; 1 outlier removed) enriched in $\delta^{13}\text{C}$. These results suggest that adults were not feeding on lower-trophic-level invertebrates during the chick-rearing period, as was predicted by central-place foraging theory.

PRODUCTIVITY OF PACIFIC COMMON EIDERS ON THE YUKON-KUSKOKWIM DELTA, ALASKA

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Pacific Common Eiders (*Somateria mollissima vnigrum*) have undergone a dramatic population decline over the past 50 years. Currently, only sparse information exists on their demography and factors potentially influencing their decline. Our study was aimed at developing a population model to compare survival and reproduction among areas and years and examining the relative influence of these parameters on population dynamics. Here, we report the reproductive component of the study, composed of nesting results from fourteen breeding seasons across three sites on the YKD. Nest-initiation dates ranged from 4 May–27 June and varied among study areas and years. Breeders at the island site consistently initiated three to five days earlier than mainland nesters. Average clutch size (5.02 ± 0.08 SE) did not vary among locations, but did vary seasonally (declining at -0.01 ± 0.007 SE eggs/day) and among years (range 4.97–5.06 eggs). We hypothesized that annual, geographic, social, body condition, and contaminant-related covariates affected nest survival, and we examined these potential effects using program MARK. We will discuss these results, as well as the relative influence of reproduction on overall population growth and associated management implications.

KEEPING COMMON BIRDS COMMON: WILL FISH-EATING BIRDS BECOME AN EXCEPTION? THE DOUBLE-CRESTED CORMORANT IN MINNESOTA AS A CASE STUDY

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In Minnesota, we conducted the first-ever statewide census for Double-crested Cormorants and American White Pelicans in 2004. The census was undertaken because the DCCO Public Resource Depredation Order was established in 2003 and the MN Department of Natural Resources needed baseline information for this species in case control efforts were initiated. American White Pelicans were included in the census because this species has increased in the state, and complaints about its impact on aquaculture and fisheries have increased. The census effort estimated 16,200 pairs of DCCO at 38 sites and about 16,500 pairs of AWPE at 16 sites. In the context of species history, regional distribution and abundance, and relative to other colonial species, MN's DCCO colonies and population are not unusually large. However, DCCOs in MN are perceived as "overabundant," and management for this species is being considered and/or has been undertaken to achieve fishery objectives. The return of the Double-crested Cormorant to Minnesota as a common species has been highly controversial because fishery objectives strongly influence natural-resource management. We suggest that fishery objectives may limit the applicability of NABCI's (North American Bird Conservation Initiative) goal of "keeping common birds common" to fish-eating birds.

BREEDING BIOLOGY OF THE XANTUS'S MURRELET AT WEST SAN BENITO ISLAND, BAJA CALIFORNIA

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We report the first detailed information on phenology, hatching success, and assortative pairing of the Xantus's Murrelet (*Synthliboramphus hypoleucus*) in México at West San Benito Island, Baja California, during January–June 2003 and 2004. We compare murrelet breeding biology at the San Benito Islands, where egg predators are absent, with that at Santa Barbara, CA, where egg predators are present, and assess the level of assortative pairing between the two subspecies, *S. h. hypoleucus* and *S. h. scrippsi*. In 2003, egg-laying at San Benito Island began in mid-March and began 3 weeks later on Santa Barbara Island. The mean number of eggs hatched/nest at San Benito in 2003 was 0.55 (SD = 0.82, $n = 29$), which is significantly lower than that reported on Santa Barbara, (mean = 1.17, SD = 0.60, $n = 45$), although causes of egg failure differed. On San Benito, 69% of failed eggs were abandoned, whereas most failed eggs (43%) on Santa Barbara were depredated by mice, suggesting that different mechanisms affect productivity at each colony. We confirmed facial patterns of 20 breeding pairs and found a low level of interbreeding between subspecies.

WHOSE SAURY NOW? WHY ADULT AND NESTLING SEABIRDS HAVE DIFFERENT DIETS

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Stable-isotope ratios of nitrogen and carbon in blood differ between adults and nestlings in four alcid species breeding on Triangle Island, British Columbia. Moreover, adult isotope ratios during provisioning differ from those measured in earlier breeding stages. These data show that nestling and adult diets differ in trophic level (nitrogen isotopes) and/or the location of prey capture (carbon isotopes). We use a simple foraging model to explain these phenomena. In the model, provisioning adults travel from the colony to collect prey for delivery, and in addition must spend some time searching for and consuming prey to cover their own energetic costs (self-feeding time). The prey best for delivery and those best for self-feeding and are not necessarily the same, and in patchy environments may be found in different places. A provisioner's choice is between traveling to different places for each task or undertaking both at a single site. A single site requires less travel time, but prey capture for both tasks takes longer there. The model identifies the circumstances under which the two-patch tactic is favored and shows that the effect is surprisingly powerful.

POPULATION DYNAMICS OF COMMON MURRES ON TATOOSH ISLAND, WASHINGTON [Poster]
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Long-lived seabirds such as albatrosses and shearwaters are known to skip breeding in some years. Causes have been attributed to both intrinsic (individual quality) and extrinsic (environmental) factors. At Tatoosh Island in Washington, numbers of Common Murres (*Uria aalge*) breeding on cliffside subcolonies have been increasing since 1992, with the exception of 1999, when the population decreased by 36%. Because the population rebounded the following year, we attribute the drop in 1999 to a smaller proportion of breeders attending the colony rather than a true decline in the population. In the absence of an individually-marked population, we use maximum-likelihood estimation methods to parameterize a population dynamics model that quantifies the influence of environmental factors such as ocean climate, (“bottom-up” forcing) and eagle disturbance (“top-down” forcing) at the population level. Neither factor alone can explain the one-year decline in the annual proportion of breeders at the colony. We discuss the relative influences of these factors as well as immigration to the greater population at Tatoosh.

SIMULATING THE EFFECTS OF PREDATION AND EGG-HARVEST AT A GULL COLONY
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We developed an individual-based simulation model to explore the effects of harvesting eggs from a Glaucous-winged Gull (*Larus glaucescens*) colony that also experiences egg loss from avian predators. The model has direct application to Glacier Bay National Park, where resource managers are interested in the potential effects of traditional harvesting of gull eggs at colonies within the park. This model simulates the sequence of egg laying, relaying, and incubation to hatching for individual nests and calculates hatching success, incubation length, and total eggs laid in all nests during the simulation. Stochasticity is incorporated in the distribution of nest lay dates and in which nests are attacked during predation and harvest events. We used maximum-likelihood to estimate parameters by fitting the model to data collected at South Marble Island in 1999 and 2000. We then simulated harvests and analyzed model predictions. Model outputs suggest that harvesting early, at one time and from no more than 20% of the colony, provides a constant harvest with the least impact to gulls.

THE COLUMBIA RIVER PLUME AS SEABIRD FORAGING HABITAT ON THE OREGON AND WASHINGTON COASTS
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The Columbia River Plume is one of the most prominent and dynamic physical habitat features in the nearshore environment of Washington and Oregon. Strong horizontal and vertical gradients in salinity and current velocity are associated with the plume. Little quantitative information is available about seabird use of the plume environment. We are investigating the importance of the Columbia River Plume as a foraging habitat for seabirds. We use at-sea and land-based surveys to characterize bird distribution and behavior relative to the distribution of physical water properties and marine food-web structure. Cross-shelf at-sea surveys take place in May and June. Weekly land-based surveys provide half-hourly bird counts from dawn to dusk. Preliminary results show that large numbers of Common Murres, dark shearwaters, and Western Grebes aggregate in or near the plume and plume front. Both behavioral aggregation for feeding and physical aggregation driven by surface currents appear to be responsible for the creation and dissipation of seabird aggregations. Future investigation should seek to identify the population origin and the diet composition of birds found in this habitat.

NESTING BEHAVIOR AND REPRODUCTIVE SUCCESS OF NEWELL'S SHEARWATERS

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Newell's Shearwaters (*Puffinus auricularis newelli*) nest primarily on steep, inaccessible slopes of the interior mountains of Kauai, Hawaii. However, two pairs nested in artificial burrows near the coast at Kilauea Point National Wildlife Refuge, providing a rare opportunity to gain information on their nesting ecology. We present data on breeding, nesting, and chick provisioning behavior not previously described. Newell's Shearwaters arrive on island mid- to late April, excavate a burrow, copulate, depart on a pre-laying exodus, then return to lay one egg in late May to early June. The male assumes the first of six incubation shifts and will incubate for a longer period than the female. Incubation intervals averaged 10.2 days, and incubation periods were 53 and 54 days for the two nests in 2004. The newly hatched chicks were attended throughout each night and intermittently during the day up to 6 days. Thereafter, at least one parent visited most nights until the chicks fledged (81 to 94 days). Parents exhibited amazing synchrony in nightly returns to the chick, with females returning for 6 to 7 consecutive nights and males for 7 to 10 consecutive nights. Chick weights were taken several times/week and compared among years. The chicks of 2003 averaged a higher overall weight than the chicks of 2004 and fledged earlier.

RESULTS OF BEACHED-BIRD SURVEYS IN THE EASTERN BALTIC

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Beached-bird surveys were conducted during 1991–2003 along the Lithuanian coast of the Baltic Sea. Stranded bird densities averaged 0.3 carcasses/km shoreline; however, densities varied between different sections of the coast. About 27% of bird carcasses had oiled plumage. No temporal trends were detected in beached-bird densities and oiling rates in the course of the study. Beached-bird species-composition, however, significantly changed, with decreasing proportions of gulls and an increasing share of diving birds. A number of birds were identified as drowned in gillnets of a nearshore fishery that started and developed rapidly during the study period. The proportion of birds that died in fishing nets increased remarkably during the study period and correlated with the increased proportion of diving birds. Additional bird mortality by the gillnet fishery obscured interpretation of beached-bird survey results in relation to chronic oil pollution because it was often difficult to identify whether birds died in fishing nets or due to other reasons. Temporal and spatial variation of fishing effort also did not allow an assumption of constant mortality rate due to this reason.