A broad transition zone, where the California Current mixes with warmer and saltier waters to the south, separates distinct subarctic and subtropical species assemblages off the West Coast of North America. The location of this ecotone is influenced by seasonal and interannual oceanographic variability. In particular, latitudinal shifts in zooplankton, fish and seabird distributions are associated with anomalous ocean temperature conditions. Subtropical species become more numerous during warm-water events, while subarctic taxa are numerically dominant during cold-water periods. However, little is known about community-level changes in response to shifting ocean conditions. Herein, I contrast seabird community structure off southern California during the spring and fall of an El Niño (ENSO) event (Sep 1997, Apr 1998), a La Niña (LNSO) episode (Sep 1998, Apr 1999), and a "non ENSO/LNSO" year (Apr 1996, Sep 1996).

Substantial changes in the avifauna were apparent off southern California during El Niño and La Niña. During spring, species richness was higher during the El Niño and La Niña events. In 1996, the avifauna consisted of 22 species and was dominated by phalaropes (*Phalaropus* spp.; 82% of all birds). During the 1998 El Niño, the community included 26 species, none of which accounted for more than 20% of total bird numbers. During the 1999 La Niña, the avifauna consisted of 28 species and was dominated by Sooty Shearwaters (*Puffinus griseus*; 30% of all birds). Conversely, during fall, species richness was higher in 1996, when Sooty Shearwaters (32% of all birds) dominated a community of 22 species. During El Niño conditions, the avifauna was dominated by Black-vented Shearwaters (*Puffinus opisthomelas*; 37% of all birds), and species richness declined to 17. In 1998, Pink-footed Shearwater (*Puffinus creatopus*; 57% of all birds) became the dominant taxon and species richness increased to 21.

These changes in community structure off southern California were driven by fluctuations in the relative abundance of taxa with distinct biogeographic and temperature affinities. Subarctic species were most numerous in spring of 1996, while subtropical taxa were most abundant during El Niño. Endemic, cosmopolitan, and transition domain taxa became more important during anomalous conditions. Similarly, the abundance of species with an affinity for warm and cold water varied significantly across years. Cold-water taxa were most abundant during the fall of 1996 and the spring of 1999, while warm-water species were most numerous in 1998.

These results suggest that the number, identity, and abundance of seabird species in the southern California Current vary substantially in response to interannual oceanographic variability. These results contrast with analyses from tropical water masses, where ENSO/LNSO events do not appear to alter seabird community structure and habitat associations (Ribic et al. 1992, 1997). This disparity is likely related to the differential ability of seabirds from tropical and eastern boundary currents to cope with changing ocean productivity patterns.

Prehistoric human impact on seabirds and their ecosystems

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For many breeding seabird populations in the Pacific, Polynesian voyaging canoes brought the first contact with humans between about 4,000 and 800 years ago. The consequences for seabirds included population declines, extirpations of colonies, and even extinctions of species. The subfossil evidence for this will be reviewed with a view to understanding what types of birds were affected, where they formerly bred, and what caused their decline. Consideration will be given to the possible ecological effects of a dramatic prehistoric decline in seabird populations. Predation from surface-feeding birds may formerly have played a more important role in marine food webs, for example. The transfer of marine nutrients to terrestrial landscapes by breeding seabirds may have contributed more importantly to terrestrial ecosystem function than has been realized. For humans, declining numbers of seabirds may have impeded Polynesian navigation in the Pacific and spurred greater reliance on agriculture and husbandry.

Island erosion in Willapa Bay, Washington, and effects on Brown Pelicans and other birds

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Thousands of California Brown Pelicans (*Pelecanus occidentalis californicus*) migrate annually to the Pacific Northwest and concentrate in three large adjacent estuaries during the fall; the Columbia River estuary, Willapa Bay, and Grays Harbor. Secure nocturnal communal roost habitat is limited in this sandy coastal region. In 1999, a construction project was initiated that threatened to erode the largest known traditional pelican roost site in the Pacific Northwest, a sand island in Willapa Bay that had supported up to 6000 pelicans in a single survey. We report findings from a study conducted to evaluate and monitor changes in island configuration, night roosting behavior and effects of disturbance on pelicans in Willapa Bay, as well as relative distribution of pelicans in the three key northwest estuaries. Eventual erosion of all islands at the mouth of Willapa Bay resulted in loss of pelican night roost habitat in 2001–2002, a significant decline in relative use of Willapa Bay, and an increase in use of the surrounding estuaries. East Sand Island, in the Columbia River estuary, has became the largest roost site known on the U.S.

west coast, with over 9000 pelicans present at once in 2002. Island erosion in Willapa Bay has also affected breeding gulls, terns, Snowy Plovers (*Charadrius alexandrinus*), migratory shorebirds, waterfowl, and raptors. We discuss management implications of changes in pelican distribution in the Pacific Northwest, and how human alteration of sediment transport in the Columbia River ecosystem may be linked to habitat loss in Willapa Bay.

Reproductive success of Brandt's Cormorants at three nearshore colonies in central California 1997–2001 *[Poster]*

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As a component of research and restoration efforts focusing on Common Murre (*Uria aalge*) populations, Brandt's Cormorant (*Phalacrocorax penicillatus*) breeding success was monitored for five years (1997–2001) at three locations along the mainland of central California: Point Reyes Headlands (PRH), Devil's Slide Rock and Mainland (DSR), and the Castle Hurricane Colony Complex (CHCC). Productivity was highest at PRH and lowest at CHCC in three of five years, similar to patterns in murre productivity. The most dramatic differences were recorded during the El Niño year of 1998. The timing of breeding followed a latitudinal trend; cormorants in the most northerly colony (PRH) at latitude 37° 59' 69" N laid latest in all years, and those in the most southerly colony (CHCC) at latitude 36° 22' 49" N laid earliest in all years but 1998. At CHCC and PRH the locations of groups of breeding cormorants varied from year to year at each colony. Differences in reproductive success were detected when subcolonies were compared within colony complexes. Such variation suggests a need for broad scale monitoring efforts when attempting to assess Brandt's Cormorant population parameters.

Marbled Murrelet Middlepoint molt records from British Columbia

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Middlepoint Bight on British Columbia's Sunshine Coast is one of the few sites along the Pacific Coast that has been identified as a permanent congregational molt-site for the Marbled Murrelet during August and September when birds are flightless. During this period flight feathers of this species wash up on the shorelines. In this article the author provides records of numbers of birds attending this rocky shoreline site between 1991 and 2002 and discusses their relevance to local logging activity and the conservation of the ancient forests of the Caren Range that lie a short distance from this marine molt-site. He calls for preservation of the Bight, which is vulnerable to development, as a "no-take" marine conservation area. This article supplements his 2001 book, *The Marbled Murrelets of the Caren Range and Middlepoint Bight,* published by the Western Canada Wilderness Committee of Vancouver, BC.

Black-legged Kittiwakes as bioindicators: avoiding confounding effects of predation

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In the absence of nest predation, piscivorous seabirds potentially are good indicators of forage fish abundance in marine ecosystems, because reproductive performance is readily monitored and sensitive to prey availability. We developed a simple graphical model that compares a predator-sensitive measure of productivity (chicks fledged/ nest attempt) with a predator-insensitive measure (brood size at fledge [BSF]) to identify the degree to which the breeding success of Black-legged Kittiwakes (*Rissa tridactyla*) is limited by predation vs. food. We tested model performance and the degree to which brood size at fledge is truly insensitive to predation by using data from kittiwakes breeding on St. George Island (southeastern Bering Sea, Alaska), where predators are a trivial source of nest failure, and from kittiwake colonies in the Gulf of Alaska (Chiniak Bay and Prince William Sound), where predators are more prevalent. We found that, for both regions, brood size at fledge was enriched to a greater degree by differential failure of nests with clutches or broods of 1 vs. 2 than it was reduced by partial loss of nest contents. In contrast, the relationship between BSF and productivity differed markedly between regions: on St. George, BSF exceeded 1 only at the very highest levels of productivity (when approximately 50% of nests fledge chicks); in contrast, BSF at GOA colonies was approximately 1.3 across the full range of productivity (0–60%). On the surface, the ability of some GOA kittiwakes to fledge 2 chicks in years of nearly complete colony failure, and the inability of most St. George kittiwakes to fledge 2 chicks even in years of high productivity, suggest that reproductive output is prey-limited on St. George and predator-limited in the GOA. However, comparisons of BSF with chick growth rate and other predator-independent reproductive measures indicate that enhanced BSF for kittiwakes in the GOA vs. St George Island is independent of predation, and that the relationship between BSF and prey differs fundamentally between these two areas. Although BSF may serve as a predator-independent indicator of

foraging conditions within a particular colony, caution needs to be applied when comparing data from colonies in different regions.

Brown Pelican disturbances at two central California Common Murre colonies *[Poster]*

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Breeding Common Murres (*Uria aalge*) have been monitored at three central California colonies since 1996. At two of these colonies (Point Reyes Headlands and Castle/Hurricane Colony Complex), disturbance by non-breeding Brown Pelicans (*Pelecanus occidentalis*) of breeding murres has been documented annually. Pelican disturbances were recorded both incidentally and during focused observations in 1999, 2000 and 2001. Directly and indirectly, pelicans were the source of the majority of observed incidences of non-anthropogenic egg and chick loss. Pelicans directly impacted murre productivity by flushing murres from their breeding sites, causing eggs and chicks to be dislodged, and by ingesting chicks. Indirectly, pelicans impacted murre productivity by flushing breeding adults, thus providing opportunities for Western Gulls (*Larus occidentalis*) and, to a lesser extent, Common Ravens (*Corvus corax*) to infiltrate colonies to take unprotected eggs and chicks. In some cases, murre chicks were forced to prematurely "fledge" when they jumped into the water in response to these disturbances. Most disturbance events that resulted in egg or chick loss were caused by juvenile pelicans acting alone. A series of disturbance events observed over a three-day period at Hurricane/Castle colony complex (Jul 5–8, 2001) are suspected to have been caused by the same juvenile pelican. This one pelican caused disturbance events at six of nine breeding rocks and was indirectly responsible for the loss of at least eight chicks and four eggs. We discuss the impacts of pelican disturbance in relation to Common Murre reproductive success and population sizes.

Distribution of seabird colonies and birds at sea relative to Alaska groundfish fisheries

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In U.S. waters, Alaska has the most seabirds and largest groundfish fishery. Inevitably, seabirds and fisheries converge, and approximately 15,400 seabirds are taken annually in Alaska longline and trawl fisheries. Conservation may be assisted by identifying "hot spots" where fishing and seabirds overlap. Toward this end, we explored the use of the North Pacific Pelagic Seabird Database (NPPSD), currently being developed, and the Beringian Seabird Colony Catalog (BSCC), both of which are independent of fishery effort. Fishing effort was mapped using data from the National Marine Fisheries Service Observer Program. Using the BSCC, we show greatest overlap between seabird colonies and fishing (mostly longlining) at 4 major Bering Sea (BS) islands and along the lower Alaska Peninsula to central Aleutian Islands (AI). The trawl fishery abuts many small colonies along western Kodiak to the eastern AI; alcids breeding there may explain their take in trawls. To date, the NPPSD only contains data to the 1980s; we assumed that general seabird distribution at regional scales is similar today. At sea, the Northern Fulmar (*Fulmaris glacialis*), the most frequent bycatch, overlaps extensively with longline fisheries, particularly along the BS continental shelf edge, where fishing effort is greatest. Shearwaters (*Puffinus* spp.) show greater overlap with trawl fisheries in the mid-shelf regions of both the BS and Gulf of Alaska (GOA), and their bycatch is highest in the trawl fishery. The Laysan Albatross (*Phoebastria immutabilis*), caught mainly in the BS, is concentrated near the central to western AI, where it overlaps with ground fisheries near shore. The Black-footed Albatross (*Phoebastria nigripes*) occurs throughout the northern GOA shelf, and it is caught mainly in the GOA. While spatial overlap coincides with occurrence of incidental take at these regional scales, our results also suggest that "hot spots" of overlap can be more specific and vary considerably among seabird species.

Incidental catch of seabirds in the set-gillnet fishery of Kodiak, Alaska, relative to seabirds abundance and distribution in the area *[Poster]*

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In 2002 the National Marine Fisheries Service studied incidental take of non-target species in the Kodiak Island (KI) set-gillnet salmon fishery. The U.S. Fish and Wildlife Service collected data on bird abundance and interactions with gear. We present preliminary results on marine bird bycatch relative to species distribution and abundance. Seabird colonies were censused in 2000–2002, and relative abundance for noncolonial species was obtained from on-site surveys. The fishery coincides with the

birds' breeding season. Approximately 170 set-gillnetters, each operating a total net length of 150 fathoms, anchor their nets to shore. Observers were distributed randomly and proportional to fishing effort among 5 districts, covering 8% of the fishery. KI has 256,000 colonially-nesting seabirds in 190 colonies. Of 18 species breeding in the colonies, 50% of the total numbers were alcids, primarily Tufted Puffins (*Fratercula cirrhata*). Of the 35 birds (10 species) taken during observed net picks (hauls of nets), alcids comprised 86%, and 23% of those were Tufted Puffins (*Fratercula cirrhata*). Cormorants (*Phalacrocorzx* spp.), which were 1% of colonial birds, comprised 9% of the bycatch. Incidental take of non-colonial birds included the Marbled Murrelet (*Brachyramphus marmoratus*) (11% of bycatch), Harlequin Duck (*Histrionicus histrionicus*) (3%), and Sooty Shearwater (*Puffinus griseus*) (3%). Pigeon Guillemots (*Cepphus columba*), while <1% of colonial birds, were widely distributed in many small colonies, and they comprised 14% of bycatch. Localized impact to small colonies may be most pronounced for this species. Common and Thick-billed Murres (*Uria aalge* and *U. lomvia*), while <1% of colonial birds on KI, comprised 34% of the bycatch. Over 70,000 murres nest within 100 km of KI, and possibly those birds or non-breeding murres account for their prominence as incidental take in this fishery.

Changes in distribution and abundance of Kittlitz's Murrelets relative to glacial recession in Prince William Sound, Alaska

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The Kittlitz's Murrelet is a rare diving seabird found in Alaska and eastern Russia. Prince William Sound (PWS), Alaska, is a population center for Kittlitz's murrelets, where they are typically found near tidewater glaciers. In PWS, USFWS marine bird surveys using randomly selected transects showed a decline in Kittlitz's between 1972 and 2000 of 85–95%, to approximately 1,000 birds. Distribution of Kittlitz's in PWS also appeared to change; once found in many fjords, in 2000 they were confined to the northwest corner of PWS. In 2001 we surveyed specifically for Kittlitz's in PWS, targeting 17 fjords and bays where they were found in the past or that had appropriate habitat. We estimated 2290 (± 1258) Kittlitz's murrelets in PWS, with 85% of the population in two fjords in the northwest corner, and another 10% in three other fjords. Using glacier accounts from the late 1980s, fjords with Kittlitz's had one or more advancing or stable glaciers. Fjords that no longer had Kittlitz's had receding glaciers or no direct glacial input. Because of their association with glaciers, one proposed link to the decline of Kittlitz's has been glacial recession, which would be consistent with our results. In other studies, fjords with receding glaciers were shown to have increased sediment loads and low productivity. If this occurs in PWS fjords, we speculate that receding glaciers reduce local prey availability or abundance for Kittlitz's. More recent data suggests that the glaciers in the northwest corner of PWS are stagnating or retreating, which might have consequences for this population of Kittlitz's Murrelets. Kittlitz's face other challenges, including oil spills, mortality in gillnets, increased tour boat traffic, and oceanic regime shifts.

On thin ice: natural history of Common Eiders breeding in the Beaufort Sea *[Poster]*

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Along the Beaufort Sea of Alaska, the Pacific race of the Common Eider, *Somateria mollissima v-nigra*, nests and raises its broods almost exclusively on barrier islands. Compared to other populations of *S. m. v-nigra*, those breeding along the Beaufort Sea face relatively harsher environmental, biological, and physiological obstacles during breeding. During 2000–2002, we studied the nesting effort and success, and brood survival of eiders nesting near Prudhoe Bay, Alaska. Sixteen islands, covering over 80 linear km, were searched for nests and monitored to determine hatching success. Females were captured and banded, and a subsample of hens was equipped with radio transmitters. Daily survival rates of nests were determined by repeated but irregular visits, and brood survival was estimated by following radio-equipped females using aerial and ground searches. Nesting effort decreased throughout the nesting sites in subsequent years. Low nesting propensity in 2002 also may have resulted from loss to (1) predation, (2) drifting sand that covered nests, (3) wave action that flooded nests or eroded islands, and (4) wind-blown ice that crushed nests. Arctic Fox, *Alopex lagopus*, accessed islands via temporary ice bridges connected to the ice pack, and depredated virtually all nests present on a given island. Glaucous Gulls, *Larus hyperboreus*, breed on the islands and depredated eggs when females were not attending nests. These factors have resulted in near total nest failure on most islands during two of the three study years. Other research groups also observed large-scale nest failure on many other islands along the Beaufort Sea during these years. Even when nests hatched, tracking radio-equipped hens in 2000 and 2001 indicated most (>95%) lost their broods. In 2000, mortality was due to the previously mentioned storm and potentially to a reovirus isolated from dead

ducklings, whereas in 2001 the explanation is less clear. Compared to other subpopulations, *S. m. v-nigra* breeding along the Beaufort Sea appear to suffer lower breeding propensity, lower nesting success and lower duckling survival. We concluded that these eiders might be breeding at their physiological extreme or in marginal habitats. Our results support aerial survey data that suggest the Beaufort Sea population of Common Eiders is declining. Active management during the breeding season, perhaps through fox removal or aversive training of gulls, may be necessary to allow this population to stabilize and eventually grow.

First incubation, captive rearing, and release of Marbled Murrelet

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Two Marbled Murrelet eggs were collected inadvertently when females were captured as part of a radiotelemetry project. Both were transported to Simon Fraser University (SFU), incubated by machine at 37.5° C and 67% humidity. They pipped after 28 days of incubation. One chick was reversed in the egg, probably during transport between the field site and SFU, and failed to hatch. The other hatched at day 30, was fed and grew normally, was transported back to the field site just prior to fledging, and was released into the wild. The chick was remarkably easy to feed and maintain. For the first 24 days of life, it was fed 1–2 g sandlance (*Ammodytes hexaptera*) that had been captured and frozen at the field site. It was fed during 2–4 ad libitum sessions per day. Begging behavior was limited to a shivering-like body movement and a quiet trill when hungrier. Consumption ranged from ca. 10g/day as a 33-g bird at hatching to a plateau of ca 50g/day from about day 14 through fledging at day 30. The chick's growth curve paralleled two published records from wild chicks in Alaskan populations. During the growth phase, the bird remained remarkably still, sitting on Astroturf carpeting in a shallow bowl kept within a cardboard box. However, just prior to fledging, it stripped off the downy off the ends of its feathers and repeatedly exercised its wings. Our success demonstrates that captive rearing and release of this threatened species could be a practical conservation tool as part of a reintroduction program for this species.

Breeding success of the Black-tailed Gull *Larus crassirostris* in relation to nest site characteristics on Hong-do island, Korea (ROK)

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In 2002, we studied breeding success of the Black-tailed Gull *Larus crassirostris* in relation to nest site characteristics on Hong-Do island, Korea (ROK). Hong-Do island is uninhabited, small, and far away from the mainland. The island was designated as a natural monument to protect the breeding site of the Black-tailed Gull by the Korean government in 1982. As the coast line of the Hong-Do island is surrounded by rocks, it is very difficult to have access to the higher part. The flora of the Hong-Do island is mainly *Carex meurocarpa*, which covers the whole island. Black-tailed Gulls nesting in two different habitats (designated *rocky* and *grass*) were compared with regard to several reproductive parameters. Vegetation cover at nest site, distance between nests, slope at nest site and closer to taller vegetation and closer overhanging rocks were measured. Vegetation height in rocky (R) was shorter than in grass (G) (R = 39.30 ± 19.79 cm, G = 59.32 ± 13.92 cm). Distance between nests in rocky was shorter than in grass(R = 70.13 ±1 8.37 cm, G = 79.79 ± 20.00 cm). Clutch size in rocky was higher than in grass(R = 2.04 ± 0.14, G = 1.68 ± 0.03). The size of clutches laid in lower parts (L) was larger than that in higher parts (H) (L = 2.07 ± 0.24, H = 1.98 ± 0.22). Breeding success in rocky was higher than that in grass(R = 49.33, G = 47.58). In addition, breeding success in nests located lower parts of the island was higher than that in higher parts (L = 53.33, H = 44.58). In grass, clutch size and breeding success were correlated with being closer to vegetation and to overhanging rocks ($r_{\text{clutch-size}}$ = 0.922, $r_{\text{breeding-success}}$ = 0.891). Breeding success in rocky also was correlated with being closer to vegetation and to overhanging rocks (r = 0.978).

Marbled Murrelet protocol surveys and their use in forest management: implications from a set of survey efforts in northern California

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PSG protocol survey data has been used to aid in management decision, yet the interpretation of these data is a subject of substantial discussion. Mad River Biologists have been conducting surveys in conjunction with training and evaluations for 10 years in Redwood National and State Parks and we have cooperated in other survey efforts assessing Marbled Murrelet (*Brachyramphus marmoratus*; MAMU) distribution and abundance in the region. Here we present data from these surveys and discuss their value as management tools.

Surveys conducted to evaluate surveyors have shown a stable detection level at Prairie Creek State Park over the past 8 years. In 2001, intensive surveys were conduced in campgrounds and control sites in state parks in northern California. These surveys included point counts for corvids and activity level surveys for Steller's Jays (*Cyanocitta stelleri;* STJA). Although Steller's Jays have been around the campgrounds at

Prairie Creek for at least 30 years at levels comparable to the present, and Steller's Jay numbers and activity levels were much greater in the campgrounds than in the control sites, murrelet detection numbers (both total and occupied) in the campgrounds were comparable to those at control sites.

This leads one to question why, after at least 30 years of presumed predation pressure from STJA in the campgrounds, have MAMU detection levels not declined? Some of the proposed answers are: (1) MAMU detection levels/ occupied behaviors do not reflect population changes; (2) More surveys are need to accurately evaluate detection trends; (3) MAMU are exploring for new nesting areas and/or the campgrounds are "sinks" surrounded by relatively undisturbed forest "sources"; (4) MAMU do not respond to high STJA numbers in campgrounds because in unaltered ecosystems STJA were not important predators on MAMU nests; or (5) STJA do not have a long term impact on MAMU populations.

A third set of data, from intensive, multiple-observer surveys in discrete stands of old-growth redwoods, indicates considerable variation in detection numbers and occupied behaviors both between stands and during the breeding season. These data are consistent with the concept of murrelets being somewhat territorial, with "resident" breeding pairs more or less uniformly distributed across the landscape.

Detection levels and occupied behavior data are relatively easy to collect. Management decisions can be made with these data; but there are limitations in our understanding of the significance of these behaviors and consequently with the types of management decisions that can be made. More information is needed on behavior of birds around occupied sites, and even better, around known nest sites. There is value in refining our understanding of these behaviors so that we have better management and monitoring tools.

Using spatial data to enhance bycatch assessments for far-ranging species: Black-footed Albatross susceptibility to pelagic longlines

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Fisheries stock assessments are based on three elements; the size of the target population, the amount of fishing effort, and catchability, the likelihood the target species will be caught by a unit of fishing effort. One important component of catchability is the level of spatial overlap between fishing effort and the target species. As fisheries worldwide also catch non target and protected species, resource managers also are required to assess the magnitude and ecological impacts of incidental take, or bycatch. Like catchability estimates for target species, catchability estimates for at-risk bycatch species also must incorporate the spatial distribution of bycatch species and its overlap with fishing effort. We suggest that incorporating spatial distribution data into bycatch assessments is critical to generate accurate bycatch estimates for seabirds and other far ranging species. Here, we illustrate the importance of integrating spatial data on fishing effort and protected species distributions by comparing bycatch estimates for the Black-footed Albatross (*Phoebastria nigripes*) generated by several spatial distribution methods. We advocate the use of fishery-dependent and fishery-independent metrics to characterize the population range, dispersion, and the overlap between protected species and longline fisheries. The assessment of global fisheries bycatch levels will require an integrated approach that accounts for the dispersion of protected species, the disparities in gear-specific catchability, and distribution of fishing effort.

Structural growth and sibling competition determine fledging age in Pigeon Guillemots

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The Alcidae show more variability in the timing of fledging than any other bird family. Understanding the factors that drive intraspecies variability in fledging behavior is an important step towards understanding selective factors that act on the evolution of fledging strategies. However, the causes of intraspecies variability are poorly understood. We used data collected in Kachemak Bay, Alaska during 1996–1998 to study factors influencing the age of fledging in Pigeon Guillemots (*Cepphus columba*; n = 68 chicks). Our objectives were to 1) test the hypothesis that wing and primary feather length are more important than body mass in determining fledging age, and 2) to examine the effects of competitive asymmetry between siblings on beta chick fledging decisions.

Chicks that hatched later in the season fledged at younger ages, but we found no seasonal decline in chick growth rates. Chicks that fledged at a younger age had longer wings and primaries, but we observed no relationship between fledging age and fledging mass. These results support the view that structural development is more important than mass in determining post-fledge survival in seabirds. Beta fledging age was affected by the degree of competitive asymmetry: beta fledging was delayed when the alpha chick was larger than the beta, but was earlier when the beta chick was larger than the alpha. The degree of competitive asymmetry was independent of beta growth patterns, and had a stronger effect on beta fledging age than did beta growth. Pigeon Guillemots are crevice-nesters, so chicks of this species likely have access to less information about the condition of neighboring chicks than do ledge-nesting species such as murres (*Uria* spp.). We suggest that the condition of a sibling may therefore be an important clue for informing fledging decisions in this species.

Fatty acids: new tools for determining diet in Leach's Storm-Petrels

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Leach's Storm-Petrels (*Oceanodroma leucorhoa;* LHSP) exhibit characteristics (e.g. feed at great distances from shore, planktivorous, regurgitations consist mostly of oil, nest in burrows, and only come to the colonies at night) that make dietary analysis by traditional methods (i.e. observations of parental feeding, analysis of stomach contents and hard parts) difficult. By sampling adipose tissue, a long-term dietary pattern (i.e. weeks to months) can be determined whereas regurgitate samples only show short-term patterns (i.e. hours to days). Very few studies have been performed on the dietary composition of LHSP, all of which have used stomach contents. Fatty acid signatures (the complex pattern of fatty acids that make up an organism) of many marine vertebrate predators are useful tools in discerning dietary composition when predators are compared to potential prey items or in determining dietary differences in two related groups of animals. We sampled adipose tissue from sexed parents (n = 12; 2001; n = 16; 2002) and chicks (n = 10; 2001; n = 15; 2002) from Baccalieu Island, the site of the world's largest LHSP colony. We also collected regurgitate samples and prey items found in regurgitate. Lipids from tissue and prey samples were then extracted, derivatized to fatty acid methyl esters and analyzed on a gas liquid chromatograph. Adult adipose tissue signatures are being modelled within a library of prey signatures to determine the proportion of different prey items. Cluster analysis is being used to compare adult and chick signatures, and male and female signatures to see if any dietary variation can be explained. Other procellariform parents have been shown to forage for their chicks on both short and long trips but mostly for themselves on long trips, and for some species males tend to forage further from shore than females. If LHSP show similar patterns, and if trip length corresponds to distance form shore (as it did in other species), parents could exhibit different signatures from their chicks and so to with males and females. Based on preliminary results, significant differences were found between parent and chick signatures, which could be due to dietary differences or nutritional requirements. Tools of this kind have been shown to be useful in studies of marine predators, including birds, and we expect that they will be extremely useful for LHSP whose foraging behavior is a challenge to study.

Diet and body condition of Spectacled Eiders wintering in pack ice of the Bering Sea

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From late December to early April, Spectacled Eiders (*Somateria fischeri*) live among leads in the Bering Sea pack ice, where they dive 40–60 m for benthic prey. Coincident with an oceanic regime shift to warmer conditions in 1976–77, the benthic community has changed and its density has decreased. Concurrently, at least one main subpopulation of Spectacled Eiders declined over 90%, with most mortality occurring away from breeding areas; this pattern raises questions about effects of benthic changes on their winter diet and late-winter body condition. In Mar–Apr 1999 and 2001, we made the first scientific cruises via icebreakers into the eider wintering area. Esophagi of collected eiders contained only clams, almost entirely *Nuculana radiata* with no trace of the once-dominant *Macoma calcarea*. Alternative prey used elsewhere by Spectacled Eiders (snails, amphipods, and other bivalves) were also available but not eaten. Eiders selected *N. radiata* of intermediate length (18–24 mm), the size containing the greatest biomass of thin-shelled clams. Whole *M. calcarea* of this length contain 62% more energy than *N. radiata*, suggesting that *N. radiata* is less profitable. Percent lipid in total body mass of eiders averaged 12 ± 3% (SD) for 26 adult males and 14 ± 3% for 12 adult females. Mean body mass (±SE) of these males in late Mar (1688 ± 21 g) was substantially higher than reported for 53 males soon after arrival at the Yukon-Kuskokwim (Y-K) Delta in late May (1494 ± 14 g). Mean body mass of these females (1550 ± 35 g) was somewhat lower than reported for 11 females upon arrival at the Y-K Delta (1623 ± 46 g). In 1999, the last Spectacled Eiders left the wintering area on 21 Apr, 4–8 weeks before their typical arrival at breeding sites; their location in the interim is unknown. Hens lose about 530 g between arrival and hatching and do not regain mass until at least 30 days later, so prebreeding reserves and habitats used to acquire them appear critical. Exceptional climate change in the arctic and subarctic, and associated changes in marine communities and ice dynamics in spring, may have had important impacts on Spectacled Eiders and three other sea duck species whose declines of 50–90% are largely unexplained.

Are introduced rats having a negative impact on the seabird breeding colony on Kiska Island, Alaska?

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During the 2001 and 2002 breeding seasons most Least Auklet (*Aethia pusilla*) breeding attempts at Kiska Island, Alaska failed (overall reproductive success: 16% in 2001 and 10% in 2002). Reproductive success was likely the lowest ever recorded at any

auklet colony and may be attributed to rat predation and parental neglect, resulting in the delayed growth and death of many of the chicks. This phenomenon is troublesome because the overall reproductive success at Kiska is significantly lower than nearby colonies ($P \leq 0.0001$) and indicates that a population decline is virtually certain. One hypothesis to explain the reproductive failure at the Sirius Point colony is predation by rats (Norway rat, *Rattus norvegicus*) that were accidentally introduced onto the island during World War II. Because of the small size of the auklets, adults, eggs and nestlings are all vulnerable to rat predation. Extensive evidence of rat predation was found around the colony in 2002 but limited evidence of rat predation was found in our productivity crevices (38 of 205 eggs disappeared, 34 of 129 chicks disappeared, and 7 of 129 chicks were found dead in their crevices due to injuries caused by rats). A second hypothesis to explain reproductive failure is the presence of a local food shortage around Kiska Island. Little direct evidence is available to support this hypothesis but the death of many Least Auklet chicks due to starvation and exposure is consistent with both rat predation and food limitation. The impacts of the introduced rats and their role in the reproductive failure of the auklets breeding at the Sirius Point colony is an extremely important issue, as this is one of the largest auklet colonies in Alaska and may be attracting breeding adults from other nearby colonies.

The Internet web page for this project is http://www.mun.ca/acwern/Kiska2002.html

Marbled Murrelets in British Columbia's lower mainland: a summary of historical and current distribution

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Historical observations have shown that the Marbled Murrelet (*Brachyramphus marmoratus*) nested in forests of the Chilliwack and Squamish Forest Districts during the last century. These areas have also experienced drastic declines (46–54%) in the amount of nesting habitat due to logging and urbanization. Despite concerns that this population of murrelets has experienced more drastic threats in British Columbia than in other locations, there has been an almost complete lack of inventory to assess the current status of this population. In 2002 radar surveys were conducted at 14 locations in the Squamish and Chilliwack forest districts. Our objectives were to determine if murrelets were still present and to assess the suitability of radar for inventory at inland sites. We detected Marbled Murrelets at 11 of 14 locations surveyed. Sites with murrelets presence include Ashlu, Elk, Clenndinning, and Furry Creeks, and the Elaho, Capilano, Seymour, Coquitlam, Pitt, Chilliwack and Fraser Rivers. Most locations had low numbers of murrelets detected (<5). The highest number of murrelets detected was 31 at Clenndinning Creek.

These results indicate that murrelets populations are still present in areas of historical occurrence throughout the lower mainland and Squamish area. Murrelet detections in the Chilliwack, Elk Creek and Fraser Rivers are over 70 km inland, at the limit of the murrelet's inland nesting range. We recommend that further inventory effort in this area to delineate the murrelet's inland range. Murrelets use several inland lakes in the Chilliwack area, which may allow them to nest at greater inland distances than previously observed. The low numbers of murrelets observed suggest that populations are much lower here than in other BC populations. Low numbers may be due in part to limitations of radar surveys in areas with complicated topography and many potential flight routes inland. We recommend further radar and inland surveys to assess population numbers and distribution.

Eating in or dining out: seabird foraging in the mid-Columbia

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The quality of a particular foraging habitat is a function of prey abundance, quality and predictability. The Columbia River is considered important foraging habitat for some seabirds because 250 million salmon smolts out-migrate from the river annually thereby providing abundant, predictable, and high quality prey. In addition, the presence of dams in the Columbia River slows the outward migration of salmon, which may facilitate foraging by seabirds. We are conducting a three-year study to assess avian impacts on salmonid stocks in the mid-Columbia River. To assess the impact of avian predation it is important to understand the degree to which locally breeding versus nonbreeding birds utilize prey in the mid-Columbia. For example, breeding seabirds may choose lower quality foraging habitats closer to nesting sites rather than foraging at more distant, higher quality sites, such as along the river. Conversely, nonbreeders are not constrained by breeding habitat decisions and would be expected to forage at the highest quality sites. In 2002, we conducted stomach content analyses on Caspian Terns (*Sterna caspia*), Ring-billed Gulls (*Larus delawarensis*), California Gulls (*Larus californicus*), and Double-crested Cormorants (*Phalacrocorax auritis*) sampled at two sites differing in foraging habitat quality and distance from breeding locations. Rock Island Dam, located on the Columbia River, is distant from breeding sites and is considered high-quality foraging habitat. The Potholes Reservoir, the nearest breeding location, provides nesting sites for seabirds, as well as

alternative foraging habitat of variable—probably lower—quality. In addition, it is known that both postbreeders and juveniles disperse to the river after the breeding season is complete, suggesting that the reservoir provides lower-quality foraging habitat compared to the river. Stomach content analyses indicate that birds are foraging close to "home," whether they are breeders linked to the Potholes Reservoir or nonbreeders dispersed along the River. However, the reservoir birds did consume a portion of their diet from the river, indicating that this latter habitat is indeed a higher quality source of food. Preliminary results suggest that in 2002, the tradeoff in location between high-quality foraging habitat and high-quality breeding habitat curtailed seabird impacts on out-migrating salmon smolts.

Nesting population changes in Pelagic and Double-crested Cormorant populations in the Strait of Georgia, British Columbia

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This study was initiated in 2000, as previous studies in the 1990's suggested that Pelagic Cormorant (*Phalacrocorax pelagicus*) and Double-crested Cormorant (*P. auritus*) nesting populations were declining in the Strait of Georgia. We conducted a complete count in 2000 and compared population estimates from counts completed in various years since the mid-1950's. We surveyed 34 pelagic and 17 Double-crested Cormorant historic and current colonies. Our analyses showed that overall counts of pelagic cormorants were down by half and Double-crested Cormorants had declined by two thirds since 1987. Pelagic Cormorants had significantly fewer nests in 2000 compared with 1987, although during that period, an increase in the population at 1 colony was noted. At Double-crested Cormorant colonies, two significant increasing trends were noted. However these increases do not offset the dramatic declines in overall population size. We suggest that the causes of declines are possibly related to a combination of Bald Eagle (*Haliaeetus leucocephalus*) disturbance, change in prey availability, and human disturbance. Recommendations for management and conservation are discussed.

The efficacy of video-based electronic monitoring for monitoring seabird interactions with commercial fisheries

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Commercial fisheries utilize various data collection processes to support information requirements for compliance monitoring, in-season fishery management, stock assessment and scientific research. In addition, information needs are expanding as a result of an increased public interest that fisheries meet long term sustainability and ecosystem-based harvesting practices. As well as increasing information needs, there are higher-quality standards for accuracy, timeliness and verifiability. The traditional methods for commercial fishery data collection include fisher-supplied logbooks and at-sea observers, and the latter are currently the only effective means to monitor bycatch and mitigation measures. At-sea observer programs are costly because of the high labor component associated with the field data collection by observers, and as a result, these programs generally have low coverage levels or fall to fisheries that have the ability to bear such costs.

Technological solutions for data collection are emerging, enabling fishery information systems to more economically meet growing demands of information quantity and quality. Technology approaches developed by Archipelago use a video-based electronic monitoring (EM) device that automatically captures a broad suite of sensor and image data during a fishing trip. A few recent projects are relevant with respect to seabird bycatch and mitigation issues. In the British Columbia halibut (*Hippoglossus stenolepis*) fishery, EM and observer data were compared, showing reliable monitoring for a variety of issues, including time and area restrictions and catch enumeration and speciation. Another recent project, carried out in conjunction with the International Pacific Halibut Commission aboard Alaska research charter vessels, examined the use of EM technology for streamer line effectiveness in Alaska. A third recent study involved the use of EM to monitor seabird interactions with the third wire of trawl gear aboard the Alaskan fleets of groundfish factory trawlers and shore-based pollock (*Theragra chalcogramma*) trawlers. These studies provide a useful assessment of strengths and weaknesses of EM-based monitoring approaches. With reliability and lower cost as drivers, electronic monitoring may be appropriate to replace or complement at-sea observer programs in some fisheries, resulting in more strategic and cost effective monitoring.

Comparative Marbled Murrelet breeding chronology in Desolation Sound and Clayoquot Sound, British Columbia *[Poster]*

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Clayoquot Sound and Desolation Sound are two well-studied Marbled Murrelet (*Brachyramphus marmoratus*) habitat areas in British Columbia (BC). Although nesting habitat is of central concern to this species, understanding the breeding chronology of Marbled Murrelets is required to accurately design monitoring programs, including radar, and to interpret activity patterns and terrestrial habitat use. Breeding chronology was recently described in Desolation Sound (1998–2000), and here we compare those data with information from Clayoquot Sound (2000–2002). We compiled and compared breeding chronology for these two sites using radiotelemetry data, observations of fish-holding behavior, and data on the appearance of newly-fledged juveniles at sea, collected from 1998–2001 in Desolation Sound and 2000–2002 in Clayoquot Sound. Differences in daytime and nighttime inshore presence were more pronounced in Clayoquot Sound. Adult murrelets occupied inshore waters early in the breeding seasons at Desolation Sound but moved inshore at night only during the late incubation period/chick-rearing period in Clayoquot Sound. Our data suggest that the murrelets' breeding season in Clayoquot Sound starts about 20 days earlier than in Desolation Sound. This finding is somewhat surprising, given that Desolation Sound and Clayoquot Sound are at approximately the same latitude. Notably, radiotelemetry alone was insufficient to compile a breeding chronology in Clayoquot Sound. This was because the timing of radiotagging here seemed strongly dependent on the birds' behavior early in the breeding season, resulting in a small sample of radiotagged nesters. Underlying causes of the differences in breeding chronology between these two sites in BC require more study, but this finding should be considered when planning monitoring programs.

Evaluating post-surgery mortality and radio performance for several radio-attachment methods on White-Winged and Surf Scoters *[Poster]*

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Previous studies have shown high post-surgery mortality for Surf and White-winged Scoters (*Melanitta perspicillata* and *M. fusca*) with satellite transmitters implanted abdominally. We contrasted post-surgery mortality rates of scoters with several conventional VHF radio attachment methods, to determine whether the documented high mortality rates were related to the radio attachment procedure. We captured 95 scoters (37 Surf Scoter and 58 White-winged Scoters) between 10 and 20 Dec 2001, using a floating mist net setup, in Baynes Sound on Vancouver Island. Each bird was marked with one of four transmitter types, as follows: abdominal implants with external antennae (AB-EXT; $n = 39$ birds), abdominal implants with coiled internal antennae (AB-INT; $n = 19$), transmitters implanted subcutaneously and dorsally (i.e., no invasion of the abdominal cavity; SUBCU; $n = 19$), and transmitters mounted dorsally and attached with a subcutaneous prong and glue (PRONG; $n = 18$). Mortality rates in the 30 days post-surgery were similar among radio types: AB-EXT = 0.08, AB-INT = 0.11, SUBCU = 0.11, and PRONG = 0.11. This suggests that neither the invasion of the abdominal cavity nor the external antenna associated with the AB-EXT attachment method were directly related to scoter mortality. However, the mortality rates in our study, even with the least invasive protocols, were considerably higher than in other study species with AB-EXT radio attachment (e.g., Harlequin Duck [*Histrionicus histrionicus*] 14-day post-surgery mortality = 0.03), suggesting that scoters may be particularly sensitive to handling.

We also compared the performance of the different transmitter types from Jan 22 to Apr 23, in terms of proportions lost or missing and signal strength. After the approximately 3-month period, similarly high proportions of PRONG and SUBCU radios were either missing (0.44 and 0.41, respectively) or known to be shed (0.25 and 0.18, respectively). None of the AB-EXT or AB-INT were shed, and proportions missing were 0.19 and 0.11, respectively. Signal strength was similar among radio types, with the exception of the AB-INT radios, which had markedly reduced signal strength. Thus, for long-term studies of scoter winter ecology, survival rates and potential use of satellite technology, the AB-EXT appears to be the most appropriate radio type. However, for studies with < 3-month duration (e.g., breeding biology, short-term movements), the PRONG and SUBCU types are suitable and logistically easier to deploy. AB-INT radios are limited due to their short detection distances and may only be useful in very specific circumstances.

Diet and provisioning rates of Common Murres: patterns on multiple time scales

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Prey abundance and availability has major impacts on seabird demographic and population dynamics. Changes in prey availability may have effects over

multiple time scales. Herein, we examine a 30 year dataset on Common Murre (*Uria aalge*) chick provisioning at South East Farallon Island, California (SEFI). We investigate temporal variation in diet and feeding rates and potential implications for murre population dynamics. The diet composition of SEFI murre chicks has been consistently dominated by juvenile rockfish (*Sebastes* spp.) and northern anchovy (*Engraulis mordax*); however, the relative use of these two prey species varies among years and decades. We investigated seasonal characteristics of murre diet and other provisioning characteristics relative to annual and decadal variability and trends. Within provisioning seasons (typically 4–6 wk in each year), the relative use of prey species often shifted dramatically. Frequently a decline in the proportion of rockfish in the diet was observed though in many other years the proportion of rockfish in the diet was consistent and, in a few years, even increased.

Overall, feeding frequency was much higher in years and on days when there were higher proportions of rockfish in the diet. Individual feeding frequencies ranged widely; this variation could only partially be explained by age of the chick and species composition of the diet. We discuss oceanographic and weather factors that may contribute to these and other patterns in the murre diet and we evaluate seasonal changes in diet and provisioning in relation to productivity.

Use of non-traditional fishery-independent measures for assessing relative abundance of pelagic juvenile rockfish (*Sesbastes* spp.) in central California *[Poster]*

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Juvenile rockfish form an important diet item for many upper trophic level predators, such as King Salmon (*Oncorhynchus tshawytscha*) and marine birds in the central California Current System, as well as being commercially valuable in the adult phase. Fisheries managers use a variety of factors to assess abundance including life history information, fishery landings, age and length compositions (from fisheries), and fishery-independent information such as trawl surveys. Since the 1960s, many groundfish stocks, especially rockfish, have declined due to a combination of overfishing and climate change off the west coast of North America. Our goals are twofold: (1) to develop a combined fishery-independent index of rockfish abundance that can provide managers with additional information for understanding juvenile rockfish population dynamics in central California waters; and (2) to implement an ecosystem-level approach to balance social, economic, and ecological needs in fisheries management plans. We used long-term information from 3 species of seabirds (1973–2002) that breed on Southeast Farallon Island (42 km west of San Francisco Bay), in combination with National Marine Fisheries Service central California pelagic juvenile rockfish trawls (1983–2002) and salmon gut contents (1980–1999), to develop a multivariate index of juvenile rockfish abundance (MRI = multivariate rockfish index). Our results suggest that the MRI could be useful to fisheries biologists and managers as an integrated measurement of interannual to interdecadal variability in juvenile rockfish abundance.

Oceanographic variability and seabird response off the British Columbia coast, 1996–2002

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Most marine organisms, including plankton, fish, and seabirds, are constrained to live in specific parts of the world's oceans on the basis of oceanic characteristics. Off the west coast of British Columbia, there are three distinct oceanic domains. The domains are direct manifestations of the prevailing eastward-flowing North Pacific surface currents, the North Pacific Current and the Subarctic Current (SC). The northern edge of the North Pacific Current, delineated by the Subarctic Boundary (SB), stays consistently within a few degrees of 40° N across most of the Pacific Ocean. The main characteristic of the SB is that the 34.0‰ isohaline rises abruptly from about 200 m to the surface. Near the North American coast the SC divides forming two branches; the northern branch curves to the northeast and becomes the Alaska Current; and a southern branch that turns southeast, becoming the California Current. Between these two branches lies the Transitional Domain (TD). Eastward of the TD, and restricted primarily to the edge of the Continental Shelf, is the Upwelling Domain (UD). Seaward of the TD is the Subarctic Current Domain (SCD). Since the mid-1950s, oceanographic sampling has been conducted along the1500 km route to Ocean Weather Station Papa (50° N x 145° W), known as Line P. The Line P oceanographic time-series has yielded much information about the physical and biological characteristics of these water masses. Coastal upwelling and outflow from the Strait of Juan de Fuca influence the nearshore Line P sampling stations, which cross the continental shelf to approximately the middle of the continental slope. The 32.6‰ isohaline is generally used to delineate the westward penetration of the coastal runoff. The next stations, characterized by summer depletion of nitrate, occur within the TD. This water mass extends from mid-slope to between 250 and 500 km offshore. The last stations occur

within the SCD, characterized as an area of high nutrients and low chlorophyll.

The avifauna associated with these domains is poorly known, as is their response to oceanographic variability at varying temporal and spatial scales. In this paper I examine the structure of the Line P seabird communities in each domain, and how they respond to large-scale events (such as El Niño/La Niña [ENSO]), and also to mesoscale variability (inter-annual anomalies on Line P). Changes in seabird community structure are examined in relation to oceanographic changes within each domain: both large-scale changes (warm water periods: Jun 1997, Feb 1998, Jul 2002, Sep 2002; cold water periods: Jun 1998, Feb 1999, Jun 1999, Aug/Sep 1999; and "normal" water conditions: May 1996, Aug 1996, Feb 1997, Feb 2000, Jun 2000, Sep 2000, Feb 2001, Jun 2001, Aug 2001, Feb 2002), and mesoscale changes (i.e., mean surface temperature, salinity and nitrate concentration).

Diet, productivity, and forage location of Black-legged Kittiwakes in 2001 and 2002 in Chiniak Bay, Kodiak Island, Alaska

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Food abundance is widely regarded as the most important factor determining productivity of Black-legged Kittiwakes (*Rissa tridactyla*). We hypothesized that kittiwakes breeding in Chiniak Bay would share foraging locations and would have similar diets and reproductive success. In 2001 and 2002, we collected diet sample regurgitations from kittiwake chicks at several rookeries throughout Chiniak Bay. Sandlance (*Ammodytes hexapterus*) and capelin (*Mallotus villosus*) accounted for nearly 100% of Chiniak Bay kittiwake chick diets in both 2001 and 2002, with no significant proportional difference (0.66 vs. 0.60 sandlance and 0.28 vs. 0.34 capelin) during the chick-rearing period or among colonies. While diet composition remained similar from 2001 to 2002, overall productivity (chicks fledged/nest attempt) was significantly lower in 2002 (0.48) vs. 2001 (0.71) ($P = 0.028$). No significant difference existed between 2001 and 2002 in laying success (nests with eggs/nest attempt) or hatching success (nests with chicks/nests with eggs), but fewer chicks survived through fledge (nests fledging young/nests with chicks) in 2002 than in 2001 ($P = 0.037$), possibly due to predation, storm events, or reduced total forage abundance. In both 2001 and 2002, radiotagged adult kittiwakes foraged throughout Chiniak Bay, where they may serve as useful indicators of forage fish availability and marine health in general. Preliminary triangulation analyses show some forage bouts were further outside of Chiniak Bay in 2002 than in 2001, possibly due to redistribution or change in abundance of food. Wider foraging range and decreased productivity in 2002 may indicate poorer food resources than in 2001.

U.S. Fish and Wildlife Service regional seabird conservation plan

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U.S. Fish and Wildlife Service is developing a Seabird Conservation Plan for its Region 1, the Pacific Region. The goal is long-term conservation of Pacific seabird populations and habitats. As the Federal agency with primary responsibility for management of migratory birds, and as managers of the National Wildlife Refuge System, which encompasses a significant portion of the West Coast and Pacific Island seabird nesting habitat, this plan will guide and coordinate Service activities at the Regional scale. Included in the Region are two of the most diverse seabird assemblages in the United States: the temperate species of the California Current System (California, Oregon, Washington) and the tropical seabirds of Hawaii and the U.S. Pacific Islands. An estimated 14 million seabirds representing over 55 coastal and marine species breed in the Region and millions more winter or migrate through the area. The plan will include a review of seabird resources and habitats, a description of issues and threats, and a summary of current research and monitoring efforts. All species will be prioritized by conservation need, and individual breeding species will be examined and discussed in brief profiles that summarize current information on population status, trends and threats. Data gaps and information needs will be highlighted. Threats such as interactions with fisheries, introduced species, contaminants, disease, and disturbance will be examined, and recommendations for conservation actions will be proposed. This plan will provide an overarching review and discussion of seabird conservation in the Pacific Region and will identify Service priorities for research, monitoring, and management. This will form a basis for cooperative and partnership efforts with agencies, academia, and others at all scales from local to international. This planning effort is fully integrated with the North American Waterbird Conservation Regional Plans (California Current Marine Bird Adaptive Conservation Plan and Pacific Islands Regional Waterbird Conservation Plan). A draft of the Pacific Region Seabird Conservation Plan is scheduled for release this spring.

Marbled Murrelet nest tree and nest site selection in the Pacific Northwest

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We examined nesting-habitat use of Marbled Murrelets (*Brachyramphus marmoratus*) in western Washington and Oregon between 1995 and 1999. The study area included the north Cascades and Olympic Peninsula in Washington, and the Coast Range and Klamath Mountains in Oregon. We searched for old and active murrelet nests using tree climbing in known occupied stands during the breeding season (May–Sep). Two to 13 circular climbing plots (40 m radius; $n = 215$) were established in each of our study sites ($n = 34$ and 6 in Oregon and Washington, respectively). Plot locations were randomly selected from grid points overlaid on each site. All trees with potential nest platforms in each plot were climbed. Once nests were located, detailed habitat characteristics were collected. In addition to our climbing plots, we conducted dawn surveys for murrelets (1990–1999) and climbed trees in areas of high activity to locate active nests. We used an information-theoretic approach to explore the potential relationship between the probability of murrelet nesting and each of the explanatory variables at three scales: nest platform, nest tree, and the micro-site (patch) adjacent to the nest tree. We developed 22 a priori hypotheses that we thought were the most likely factors or combinations of factors for distinguishing between nest and non-nest sites. These models were analyzed using logistic regression and AIC_c. We located 102 murrelet nests, 49 during tree climbing in plots, 25 during dawn surveys, and 27 during other tree climbing activity. Thirty-one of the nests were active on discovery. Murrelets were nesting in large ($\bar{x} = 139.2 \pm 5.6$ cm dbh), tall ($\bar{x} = 56.4 \pm 1.4$ m) conifer trees of a variety of species. Their nests were located on large ($\bar{x} = 23.0 \pm 1.2$ cm), moss-covered limbs throughout the live crown. Our analyses indicated that murrelet nesting was associated with: (1) large platforms and an abundance of moss and overhead cover at the platform scale; (2) trees with many platforms, and extensive moss and mistletoe at the tree scale; and (3) density of platforms and number of canopy layers at the site scale. Moss cover and mistletoe help to increase platform size and the availability (densities) of platforms. Forest managers should consider platform tree abundance and abundance of platforms (including dwarf mistletoe) with adequate cover and moss when attempting to provide suitable nesting habitat for this threatened seabird. In addition, access variables, such as number of canopy layers and distance to edge (or other measures of flight space), should be addressed when managing habitat for murrelets.

Post-breeding diving activity and aerobic dive limit of Common Murre (*Uria Aalge*) in Monterey Bay, California *[Poster]*

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We investigated diving behavior of Common Murre (*Uria aalge*) during the postbreeding season, Jul–Sep 2001, in Monterey Bay, California. We monitored 12 study birds for 15–60 days using radiotelemetry. We determined daily diving activity with scan surveys within 3-h time blocks throughout the day and continuous recording of radio signals. Diving activity composed 14% of the total daily time budget, less than that previously recorded for breeding Common Murres. Diving activity increased during crepuscular periods, with the majority of dives occurring during 1–2 hours of sunset. Few dives occurred during hours of darkness. Mean dive duration was 33.1 s ± 0.4 SE (n = 12 birds, 2008 dives; median = 31 s); this was within theoretical aerobic dive limits (tADL), which was 48 s. Maximum dive durations for individuals were 62–167 s. We determined a 70-s ADL (range 40–80 s, n = 12 birds) among study birds, using 10-s test threshold levels in a step function analysis. Several birds did not reach a threshold limit, indicating that they did not perform anaerobic dives. These findings indicate that post-breeding Common Murres foraging in the Monterey Bay area had reduced energetic demands (were diving less) than during the breeding season. Our empirical estimate of ADL is greater than physiological predictions. We propose that this discrepancy in ADL may be partially explained by the spleen regulating circulation of oxygenated red blood cells, enabling a greater ADL.

Density dependence and seabird population processes: fact or fable?

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The role of density dependence in influencing seabird population dynamics is of great potential importance. On the one hand, it has been suggested that seabird populations are regulated through negative density dependence, acting by way of reduced food availability per individual at high population densities. This type of density dependence implies the existence of a carrying capacity for each population. At the same time, positive density dependence can lead to destabilization of populations if survival or reproductive success (e.g., success at obtaining a mate) is reduced at low population density (referred to as the "Allee effect"). The latter is of concern for those attempting to maintain colonies despite reduction in population size as well as for those attempting to establish new colonies. Here we review the published evidence for or against the existence of either type of density dependence in seabirds. In addition, we analyze reproductive success of Brandt's Cormorants (*Phalacrocorax*

penicillatus) and Pelagic Cormorants (*Phalacrocorax pelagicus*) breeding on Southeast Farallon Island over a 30 yr time period. Neither species demonstrated density-dependent reproductive success. We present comparable analyses of Common Murre (*Uria aalge*) and Western Gull (*Larus occidentalis*) reproductive success for the same site and similar time period. We highlight the difficulties in discerning density dependence based on correlative (not experimental) studies. We conclude that effects of colony size on parental foraging behavior are substantiated but that demonstrating an ultimate effect of colony size (or population density) on reproductive success or survival remains elusive. Negative density dependence may, perhaps, be effective only at the highest levels of population density. Positive density dependence, however, is of concern for the most vulnerable seabird populations: those that are depleted or are newly formed.

Do chronic oil spills and seabirds mix on the west coast of Canada? Some preliminary results

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Chronic oil pollution (accidental or intentional small-scale oil discharges at sea, often <100 liters) has been increasingly recognized as an important factor affecting adult seabird mortality, which carries serious implications at the population level. On the East Coast of Canada, it has been estimated that chronic oil may result in as many as 300,000 seabird deaths every year off the coast of Cape St. Mary's (Newfoundland) alone. This estimate is equivalent to the seabird mortality attributed to the *Exxon Valdez* oil spill in Alaska. The West Coast of Canada is oceanographically highly productive, and this area also hosts dense populations of breeding seabirds, as well as providing important foraging areas for seabird species that either use these areas for refueling during migration or for ensuring their survivorship during their "winter." Using seabird distribution data, shipping information, and rates of oil spills, I argue that chronic oil pollution may be affecting seabirds as severely in Canada's western seaboard as in the east. Seabird mortality attributable to oil spills is not as significant overall in Beached Bird Survey data collected in various regions throughout British Columbia (1988–97); however, in some critical areas such as the west coast of Vancouver Island, the proportion of oiled carcasses approaches that found off Cape St. Mary's. I discuss this variation with respect to shipping routes, oil sightings, seabird distributions and local oceanography and wind patterns.

Natural selection and sexual dimorphism in the Brown Pelican

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We looked for evidence of natural selection on the culmen in both sexes of the California Brown Pelican (*Pelecanus occidentalis californicus*). Parametric and nonparametric regression methods were used to examine natural selection in association with survivorship. Both methods provided evidence for significant stabilizing selection, occurring only in males. The nonparametric cubic spline graphical technique revealed evidence for two sex-related fitness optima across the range of bill size in this subspecies. Mean fitness was significantly different between the sexes and 64% lower in males than in females. No significant selection was observed for females, suggesting that female bill size may be near an optimum for survival. This is supported by the observations that mortality in males was three times greater than in females and that survival selection was strong and stabilizing in males. Thus, the principal effect of selection pressure associated with survival may be to influence size differences between the sexes, rather than to determine the size of the subspecies for survival. We use this evidence to test three hypotheses on sexual size dimorphism. Our results give support to the predictions of the sexual selection hypothesis, in which selection is expected to be more intense in males and that females may be closer to the survival optimum. The degree of sexual size dimorphism was correlated with the type of nesting substrate used by each subspecies. Dimorphism in the Brown Pelican has evolved mostly in the three ground-nesting subspecies.

Do time-depth recorders affect chick provisioning behavior in Thick-billed Murres (*Uria lomvia*)?

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Time-depth recorders (TDRs) are commonly used to study the foraging behavior of marine mammals and seabirds. Whether such gear affects the behavior of free-ranging animals is a question crucial to interpretation of the data. In Thick-billed Murres, recording devices increase the hydrodynamic and aerodynamic drag during swimming and flight, which may in turn affect individuals' foraging and reproductive performance. The goal of our study was to examine the effect of time-depth

recorders on brooding male and female Thick-billed Murres at Gannet Islands, Labrador during 2000–2001. Forty-seven pairs were observed for 3–10 days from 0400 to 2200 during the brooding period, in order to quantify nest attendance, feeding frequency, and breeding success. Of these birds, a group of 24 females and 18 males (one member per nest) was captured for TDR deployment; TDRs were MK7 (25 g) or Lotek (16 g). Birds were weighed before and after TDR deployment. Within a nest, each individual was identified using paint marks or color bands and sex was determined using molecular DNA analysis. The cross sectional area of the TDRs (1.9 cm^2, 1.33% of the body area) was lower than previous diving studies of Thick-billed Murres. TDR birds had a higher mass loss rate (females [F] = 18 g/d, males [M] = 27 g/d) than control birds (F = 3.1 g/d, M = 4.6 g/d). Nest attendance was lower in TDR (11 h/d) than control birds (13 h/d) and was male-biased in both groups. Birds with TDRs fed their chicks less frequently (0.8 fish/d) than control birds (2.5 fish/d), and there were no differences between sexes. The partners of TDR birds (both males and females) increased their feeding rates significantly (3.5 fish/d) and balanced their daily chick feeding rates. Finally, the fledgling success did not differ between TDR birds (87–90%) and control birds (93–98%). These results suggest that time-depth recorders may in fact affect breeding behavior in alcids and should be taking into account in future studies.

Post-breeding dispersal of adult and juvenile radio-tagged Marbled Murrelets, Clayoquot Sound, British Columbia *[Poster]*

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Very little is known of the post-breeding movements of Marbled Murrelets (*Brachyramphus marmoratus*) throughout their range, yet basic information on the seasonal movements and distribution of populations would aid in the management of this threatened seabird. Here we present results from research investigating the postbreeding movements (Jul–Oct) of adult (n = 75) and juvenile (n = 25) Marbled Murrelets radio-tagged in Clayoquot Sound. Radio-tagged adults left the sound abruptly in late July, with nonbreeding adults leaving earlier than confirmed breeders, although not significantly so. While juveniles left the Sound later than both nonbreeding and breeding adults, this was significant for non-breeders only. Despite extensive searches along the coast from the Olympic Peninsula in Washington to Juneau in Alaska, including Vancouver Island, the mainland and the Queen Charlotte Islands, adults were only rarely detected once they had left Clayoquot Sound. This suggests an offshore movement during molt and perhaps for the winter season. In contrast, juveniles moved northwards along the coast of Vancouver Island after leaving Clayoquot Sound. Our results do not support a previous hypothesis that birds from British Columbia comprise part of the seasonal influx of murrelets into the sheltered waters of Puget Sound in Northern Washington in the fall.

Post-fledging survival of juvenile Marbled Murrelets as determined by radiotelemetry in Desolation Sound, British Columbia *[Poster]*

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Postfledging juvenile survival is difficult to measure, particularly for seabirds. However, several studies have highlighted the importance of estimates of survival during both the first year, and until first breeding. Such estimates are particularly important in the construction of population projection models, which are commonly used in studies with conservation implications. Here we report the first estimates of local survival from field data for juvenile Marbled Murrelets (*Brachyramphus marmoratus*), an alcid species of conservation concern that breeds in old-growth forest from California to Alaska. We estimated the survival of 34 radio-tagged individuals during an 80-day period post-fledging to be 0.8628 (95% CI 0.7250 to 1.001). Based on an assumption that survival is constant over time, we extrapolated the survival probability over a 365 day period to estimate an annual survival of 0.5100. Our estimate does not include mortality during the first flight to the sea, and may be biased low because of natal dispersal, but is nonetheless lower than previous estimates used in demographic modeling.

Characterizing spatial patterns of migratory shorebirds using heterogeneity indices: which indices are best?

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During migration, shorebirds occur on the landscape in spatially

discontinuous and temporally asynchronous ways. Understanding and managing these diverse land-use patterns presents a special challenge to conservationists, one that is exacerbated by incomplete information. Consequently, decisions about which sites are the right sites to protect for most shorebirds are often driven by needs of the best-studied species. One way to identify other species' habitat needs is to characterize broad-scale spatial patterns from multiple-species surveys. Although sophisticated spatial analysis techniques exist, most are inaccessible to practitioners of conservation and management. However, not all spatiotemporal questions require complex tools. Accordingly, we sought objective metrics to quantify broad-scale shorebird spatial patterns at >1,000 wetlands in the U.S., based on the International Shorebird Surveys. We used a Monte Carlo approach to test five well-known heterogeneity indices (Camargo Index of Evenness (E'), Simpson Index of Evenness (E1/D), Lloyd's Mean Crowding Index (JA, scaled), Smith Wilson Index (Evar), and Dispersion Index (D, a variant of the Shannon Diversity Index) for: (1) ability to discriminate among a range of spatial distributions; (2) robustness to variable sampling intensity and sampling protocol (random versus non-random); and (3) ability to distinguish among spatial patterns of actual data (5 shorebird species). Camargo, Simpson, and Lloyd's performed well under most simulated circumstances, and are useful tools for calculating broad spatial patterns. All five indices yielded similar results when characterizing spatial patterns of shorebirds. We recommend using several indices to maximize accuracy and information gain, and we provide examples of shorebird spatial heterogeneity.

Marbled Murrelet demography in central California

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The Marbled Murrelet (*Brachyramphus marmoratus*) is one of the most threatened seabirds along the California coast, due to a variety of potential factors such as the harvesting of its old-growth nesting habitat, oil spills, and increased nest predation. We initiated a demographic study in 1997 to estimate the murrelet's population trend in central California and to understand the environmental and demographic factors responsible for any observed declines. We estimated the population trend using three approaches, one based on at-sea counts, one using a Leslie matrix model, and one based on the recently developed suite of Pradel models. Models were parameterized with breeding, recruitment, and survival estimates from 289 banded and 46 radio-marked murrelets. We observed significant annual variation in the proportion of breeders, presumably due to annual variation in the marine environment. However, all nests failed even in a "good" year, resulting in a fecundity estimate of 0.0. Furthermore, survival rates were much lower than expected for a murrelet-sized alcid. Not surprisingly, the Leslie matrix approach parameterized with these estimates suggested a dramatic annual rate of decline. However, the trend based on both at-sea counts and the Pradel approach indicated that the population was stable. Because the latter two approaches incorporate recruitment from outside populations, while the Leslie Matrix does not, we suggest that the central California murrelet population may be sustained by immigration processes and that it constitutes a classic sink population.

Monitoring of the Double-crested Cormorant (*Phalacrocorax auritus albocilliatus*) nesting colony on Alcatraz island, Bahía de Kino, Sonora, México *[Poster]*

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In the early 1970s, informal censuses of Double-crested Cormorants (*Phalacrocorax auritus albociliatus*) were conducted on Alcatraz Island (28° 59′ N, 111° 58′ W) in the Gulf of California. Preliminary numbers of breeding pairs were recorded, and the data suggested that Alcatraz Island was one of the largest Double-crested Cormorant nesting colonies in the Gulf. However, no formal studies were conducted to document the population size of the colony. In September of 2000, Prescott College began monitoring the nesting colony on the island in an effort to obtain accurate data on the nesting period and the number of active nests on the island. We conducted weekly counts of active nests during the 2000–2001 and 2001–2002 seasons and determined that the nesting season begins in late September and continues through April. The peak in nesting activity during the 2000–2001 season was recorded on 2 Jan with a total count of 1225 active nests. In the following season, the peak was recorded in late November with a total count of 1093 active nests. This decline in nesting activity could be attributed to impacts caused by tropical depression Juliette, which affected the region in early October 2001. Preliminary results of monitoring during the 2002–2003 season show an increase in active nests, with a maximum count of approximately 1683 on 30 November. Based on

population estimates for Pacific coast nesting pairs of Double-crested Cormorants, 31% of the coastal nesting population of *P. auritus albociliatus* in the Gulf of California nested on Alcatraz Island during the 2001–2002 season. This represents 5% of the overall Pacific coast nesting population. Although Alcatraz Island is protected under the Gulf of California Island Reserve program, we believe that additional layers of protection should be implemented to ensure the future success of this important colony.

Biogeography of the northern Bering and Chukchi Sea shelf

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During summer, advection of nutrients and plankton from the Bering Sea basin to the central Chukchi Sea provides a "conveyor belt" of food to seabirds in the region. Constriction and shallow topography at Anadyr and Bering Straits cause turbulent upwelling of nutrient- and zooplankton-rich Anadyr Water as it flows northward. This results in high average levels of primary production (360 gC $m^{-2}y^{-1}$), some of which sustains the large biomass of zooplankton entrained in the Anadyr Current. Alaska Coastal Water also flows into the Chukchi Sea, providing a warm, stratified habitat for many species of pelagic fish. The region from St. Lawrence Island to the Bering Strait supports over 5 million seabirds in summer, mostly small planktivorous auklets (*Aethia* spp.; 65%) and large piscivorous murres (*Uria* spp.; 19%) and kittiwakes (*Rissa* spp.; 5%). Primary production in adjacent waters of the Chukchi Sea (420 gC $m^{-2}y^{-1}$) exceeds that below the Bering Strait. But of the 2 million seabirds in the Chukchi Region, auklets are surprisingly scarce (6%), being supplanted by planktivorous phalaropes (25%) and piscivorous murres (38%) and kittiwakes (15%). Auklets account for 49% of total areal food consumption (411 mt d^{-1}) below Bering Strait, whereas piscivores are dominant (88% of 179 mt d^{-1}) in the Chukchi Sea. Average carbon flux to seabirds (0.65 mgC $m^{-2}d^{-1}$) over the whole region is typical of upwelling ecosystems. In summary, distribution of seabirds in the region appears to be a function of both high productivity and water column stability. Planktivores flourish in areas with high zooplankton concentrations on the edge of upwelling and frontal zones, whereas piscivores avoid turbulence and forage in stable, stratified coastal waters and in stratified waters at the end of the Anadyr "conveyor belt" in the central Chukchi Sea.

Physiographic island evolution as a factor in structuring seabird communities: evidence from a temperate and a tropical setting

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In this paper we suggest a novel factor in shaping seabird communities: physiographic island evolution, i.e., the predictable physical changes that occur in islands over time. We cite examples from a temperate setting (coastal Oregon and Washington state) and a tropical setting (the Hawaiian islands). Off Oregon and Washington, new islands are formed as land masses break away from headlands. Initially they are covered with vegetation and soil but these are lost as the island weathers and become bare rock. The first seabird inhabitants are mainly burrow- or vegetation-nesters; these are ultimately replaced by surface-nesting species, often larger, typically of the same genera or families. In the Hawaiian islands, a similar process occurs: islands are formed by volcanic eruptions and during a relatively long vegetated period the islands are inhabited mainly by burrow- and tree-nesting species. Later on, after weathering has eliminated the high island and only bare rock or a coral atoll remains, the initial inhabitants are replaced by often larger forms of surface nesting species of related groups of birds. The upshot of this is that the predominance of birds forming communities at sea, on a regional basis, will be heavily dependent upon the relative age and condition of breeding islands that those birds nest upon.

A 1000-year record of Adélie Penguin diets in the southern Ross Sea, Antarctica *[Poster]*

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Non-krill prey remains were recovered from ornithogenic sediments at three active Adélie Penguin (*Pygoscelis adeliae*) colonies on Ross Island, to assess long-term dietary trends in this species. Radiocarbon dates place the age of these deposits from a maximum of 947 years ago to the present. We identified 12 taxa of fish and two of squid, with the Antarctic silverfish (*Pleuragramma antarcticum*) as the most abundant prey species represented at all sites. In addition, silverfish have decreased in importance in Adélie Penguin diet over the past 600 years, perhaps in response to climate change since the onset of the Little Ice Age, though it remains much more abundant in current penguin diet in the Ross Sea than in the Antarctic Peninsula. Other prey taxa reflect the diversity of prey selection by Adélie Penguins in Antarctica.

Using historical oil spill data to predict seabird mortality from small oil spills

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Seabird mortality resulting from oil spills is often widely variable depending on spill size, spill location,

time of year, bird densities, and other factors. Predictability of seabird mortality is especially difficult for small spills since effects are highly variable depending on local conditions and distribution of birds. Furthermore, effort expended searching beaches for affected birds subsequent to small spills tends to be considerably less than subsequent to large spills, so that data often are not available for making informed seabird mortality estimates. Spills occurring further offshore also tend to be more difficult in predicting seabird mortality since the possibility of at-sea loss is greater and more variable. We compiled and analyzed existing data from historical spills to develop a statistical model that estimates the level and variability in seabird mortality resulting from a spill of known quantity and at a known location. The result is a tool used to predict seabird mortality in order to assess damages in cases where little or no data on beached birds are available.

Seabird trends on Alaska Maritime National Wildlife Refuge provide insight into causes of endangered Steller Ssea lion declines

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A long-term monitoring program for seabirds has been underway on Alaska Maritime National Wildlife Refuge for more than 20 years. Monitoring sites for seabirds coincide with some of the monitoring sites for Steller sea lion (*Eumetopias jubatus*), a species listed as "endangered" in 1997 due to substantial population declines. Possible changes in the marine food web have been suggested as a major contributor to sea lion declines. Seabirds monitored in the same geographic region where sea lions declined provide a basis for evaluating how the marine food web might have changed over the past 20 years. Various species of seabirds use different trophic levels and provide a basis for understanding whether declines have occurred in primary productivity (reflected by planktivores) or reduction in the forage fish base (reflected by piscivores). We predicted that if major declines in the carrying capacity of the marine ecosystem for sea lions in the northern Gulf of Alaska and Aleutian Islands have occurred in the past 20 years, seabird populations should also have declined in this region. While some species declined in some places, there were not widespread sustained declines. This suggests that seabirds were unaffected by the factors causing the Steller Sea Lion decline.

Gull predation as a factor in the evolution of plumage variation of Least Auklets (*Aethia pusilla*)

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The Least Auklet (*Aethia pusilla*), probably the most abundant seabird in the Bering Sea, displays an unusual amount of polymorphism in its breeding plumage. Predation pressure by Glaucous-winged Gulls (*Larus glaucescens*) could be a driving force behind the evolution of Least Auklet plumage polymorphism. To test whether gulls have a preference for a certain plumage type, I performed an experiment in which I observed gull attack rates on manipulated models. Gulls might prefer a plumage type because it is easier to detect, provides a better meal, or because it is correlated with an auklet's ability to escape during an attack. Acceleration during takeoff of captured auklets was measured from videotape using digital single frame analysis. Time-location data was smoothed using cubic splines. Velocities after one second and maximum accelerations and were determined from first and second derivative of the spline, respectively. I will discuss the potential of takeoff acceleration as a cheap measure of a bird's condition.

Do scaup and scoters prefer foreign food in San Francisco Bay?

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The San Francisco Bay Estuary is an important wintering area for diving ducks. In 1986, a major change in the prey community occurred with introduction of the Asian clam (*Potamocorbula amurensis*). *P. amurensis* is 5 times more abundant than the native *Macoma balthica* in the top 5 cm of sediments, and on average *P. amurensis* is 8 mm long while *M. balthica* is 16.5 mm long. Scaup currently feed heavily on *P. amurensis* while seldom eating *M. balthica*. Effects of differences in size, nutrient content, digestibility, density, and depth in the sediments on the relative value of invasive *P. amurensis* were unknown. We compared the foraging value to Lesser Scaup (*Aythya affinis*) of the exotic *P. amurensis* and the formerly dominant clam *M. balthica*. In addition, more recent data on the foraging relations of White-winged Scoters (*Melanitta fusca*) in San Francisco Bay will also be presented. We measured the nutrient content and digestibility of these species, and intake rates for different prey densities, sizes, and depths in the sediments. *P. amurensis* including shells had higher nitrogen and energy content per clam of the same length class, and higher digestibility of energy, than *M. balthica*. For scaup foraging in an aquarium, intake rates (number per s) of food items buried in sand-filled trays increased with increasing prey density up to at least 4,000/m^2. For items buried 3 cm deep, intake rate did not differ for prey <6 mm long versus 6–12 mm long; however, intake rates were much lower when prey were deeper in the sediments (6 cm *versus* 3 cm). In contrast, prey size and depth in the sediment affected the intake rates of White-winged Scoters. In tensometer measurements, shells of *P. amurensis* were much harder to crush than shells of *M. balthica*, which might partly offset the

apparent energetic advantages of *P. amurensis*. When intake for scaup is expressed in terms of nitrogen and energy, the exotic *P. amurensis* appears to be a better food than *M. balthica* at the same densities. However, *P. amurensis* accumulates much higher levels of some contaminants, increasing the risk of toxicity to diving ducks. This study will assist in modeling the food requirements and contaminant exposure of diving ducks in the Bay.

The extreme life histories of pelagic seabirds

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Pelagic seabirds, including petrels, penguins, boobies, and many gulls and terns, among others, exhibit extreme life histories among birds. Such life histories include long development periods, delayed maturity, low reproductive rates, and high survival rates. These traits are associated with the particular environment of the open ocean, the extreme mobility of pelagic seabirds, and the constraint imposed by feeding at great distance on food provisioning of the chick. One consequence of the single-chick brood of pelagic seabirds is the absence of within-brood sibling competition, which permits the evolution of long development periods. Among the benefits of slow growth are energy and nutrient economies, however the significance of long incubation periods is not yet known. Moreover, because intermediates between the life histories of pelagic seabirds and coastal seabirds are lacking, the evolutionary transition between the two is not apparent. Using a variety of phylogenetic and comparative analyses, I shall try to fill in some of these gaps in our appreciation of the lives of pelagic seabirds.

Behavioral effects of oil exposure on captive Harlequin Ducks

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Harlequin ducks (*Histrionicus histrionicus*) wintering in areas of Prince William Sound, Alaska affected by the 1989 *Exxon Valdez* oil spill have shown reduced winter survival through at least 1998. To examine the effects of chronic exposure to oil on behavior that may contribute to survival reduction in the wild, we conducted oil dosing and external oiling experiments with adult female harlequin ducks in captivity at the Alaska SeaLife Center. Time-activity budgets of captive birds were dominated by time spent resting and did not differ between oil-dosed and control treatments in either of the two years of the oil dosing study. External plumage oiling over a 7-day period caused differences in time spent in maintenance ($F_{3,155} = 2.61$, $P = 0.05$), and feeding behaviors ($F_{3,156} = 6.15$, $P < 0.01$). Time spent in maintenance behaviors by externally oiled birds was greater than that of controls. Time spent feeding decreased in externally oiled birds, while food consumption did not differ between treatments ($F_{3,3} = 4.90$, $P = 0.11$), indicating that oiled birds fed more efficiently, possibly to minimize the thermoregulatory costs of dive feeding with oiled plumage. These results suggest behavioral effects of external exposure to lingering oil in Prince William Sound may hold consequences to winter survival of harlequin ducks that are more significant than those of oil ingestion. However, oil ingestion occurring simultaneously with rigorous winter conditions experienced by free ranging harlequin ducks could have an additive effect, which may have been absent in captivity where conditions were more hospitable. Inferences drawn from behavior in captivity, therefore, may be limited.

Monitoring nocturnal diving activity of Harlequin Ducks on their wintering grounds using radiotelemetry *[Poster]*

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We monitored radio signal pulse rates of 10 radio-marked harlequin ducks wintering in Resurrection Bay, Alaska from November 2001 through February 2002 for evidence of nocturnal foraging. Pulse rate was measured for each detected signal as an indicator of diving behavior. Direct daytime observation of radio-marked birds confirmed that no pulses were detected during dives. Average pulse rate was lower during diurnal than during nocturnal detections. Signal reception remained constant for all nocturnal detections ($n = 164$), while reception remained constant in 30% of diurnal observations ($n = 76$). These observations support the hypothesis that harlequin ducks forage only during daylight. Feeding only during daylight greatly reduces available foraging time and suggests that harlequin ducks wintering in Alaska have little flexibility in winter time-activity budgets to accommodate anthropogenic disturbance.

Cuddling up to cormorants: nesting Brandt's Cormorants as visual cues attracting Common Murres to ephemeral breeding sites in central California *[Poster]*

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Aerial photographic survey data and ground-based colony monitoring data were used to determine whether the presence of breeding Brandt's Cormorants (*Phalacrocorax penicillatus*) increased the likelihood that Common Murres (*Uria aalge*) attended particular ephemeral subcolonies in central California in particular years. We defined an ephemeral subcolony as a subcolony where murres occasionally attended and possibly nested but were not present every year. We examined 20 years of aerial survey data from 20 ephemeral subcolonies in the Point Reyes Headlands and Castle/Hurricane Colony Complex. Results are reported in subcolony-years. Murres were seen in 101 of the 379 subcolony-years examined. Attendance patterns show that murres were more likely to be present in years when Brandt's Cormorants were nesting (74 of 101 subcolony-years). Additionally, in most years when Common Murres attended without Brandt's Cormorants, the two species had co-attended at that subcolony in the previous one or two years (23 of 27 subcolony-years). The presence of breeding cormorants with murres suggests a benefit to one or both species. Seasonal attendance data, gathered from ground based monitoring, shows that cormorants arrive earlier than murres at some subcolonies. The cormorants, being larger birds, may provide murres with additional protection from predators, allowing for small groups of murres to attempt breeding at sites that might otherwise be unattended. Understanding the role cormorants play in murre attendance patterns may help us with our efforts to reestablish historical murre colonies in central California using social attraction methods.

Modeling marine foraging habitats of Marbled Murrelets in Pacific Rim National Park Reserve of Canada *[Poster]*

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We present an overview from year one of a project examining marine foraging habitats of the threatened Marbled Murrelet (*Brachyramphus marmoratus*) in coastal regions of Pacific Rim National Park Reserve of Canada (PRNPRC). The project was funded by the Canadian government Interdepartmental Recovery Fund. The overall goal of the project is to develop a predictive GIS-based model that can identify foraging habitats of Marbled Murrelet using oceanographic data from satellite imagery, oceanographic models, and empirical data describing key fish prey species. In this poster, we present an overview of the information contained in the GIS, including at-sea distributions of Marbled Murrelets, sea surface temperatures and ocean color data derived from satellite imagery, currents and tidal mixing data from oceanographic models, and depth and exposure information from digital bathymetric charts. We also present preliminary data from beach seine surveys of forage species conducted at more than 80 sites in Barkley Sound from Jun to Aug 2002. Pacific sand lance (*Ammodytes hexapterus*), an important prey species of Marbled Murrelets, were caught at about 25% of the sites. Combined, the field data and historical data will form the foundation for the development of a GIS-based model for defining foraging habitats of Marbled Murrelets. We anticipate that results from the project will provide the necessary scientific advice required by managers to implement tools for enhancing the recovery of Marbled Murrelets by protecting foraging habitats in coastal regions of PRNPRC, and elsewhere.

Should Double-crested Cormorants at the expanding colony in the Columbia River estuary be subjected to lethal control?

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The U.S. Fish and Wildlife Service recently reopened the public comment period for their "Draft Environmental Impact Statement: Double-crested Cormorant Management," wherein the preferred alternative was issuance of a Public Resource Depredation Order allowing lethal control of the species throughout the U.S. Although the nominate subspecies, *Phalacrocorax auritus auritus*, has erupted in some parts of its range in central and eastern North America, numbers of the West Coast subspecies, *P. a. albociliatus* have evidently not increased and may have declined in recent years. The largest breeding colony of this subspecies is located on East Sand Island in the Columbia River estuary. Unlike other colonies in the Pacific Northwest, this colony grew dramatically over the past 13 years and now includes 8600 nesting pairs, the largest colony of this species on the Pacific coast of North America. Due to increasing concern over avian predation on juvenile salmonids in the Columbia River estuary, there is a need to understand the factors limiting the size and productivity of this colony. During our recent study in 2000 and 2001, we found no evidence that density-dependent feedback was limiting the size or productivity of the colony. The colony recently fragmented into separate subcolonies; overall reproductive success was higher at a newly formed satellite subcolony compared to the older main colony. Depredation of cormorant nests by Glaucous-winged/Western Gulls (*Larus glaucescens* X *L. occidentalis*) following disturbances by bald eagles (*Haliaeetus leucocephalus*) appeared to be the primary factor limiting reproduc-

tive success. Neither nesting habitat or food supply appeared to be limiting colony size or reproductive success. We predict that the colony will continue to expand unless forage fish stocks decline and/or eagle disturbances increase. The East Sand Island cormorant colony now appears to represent >30% of the entire population of the West Coast subspecies *P. a. albociliatus*. Because of declines at other colonies of this distinct population segment, the East Sand Island cormorant colony is of conservation concern, as well as the threatened and endangered salmonid stocks that represent part of its food supply. Management to limit the size of the East Sand Island cormorant colony should not be initiated until a regional conservation and management plan for the subspecies is in place and former colonies have been restored.

Changing ocean conditions and avian predation on juvenile salmonids in the Columbia River estuary

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Poor returns of anadromous salmon were nearly ubiquitous in the Pacific Northwest during the positive Pacific Decadal Oscillation (PDO) of the 1980s and 1990s. One hypothesis to explain these low adult returns was that the poor ocean conditions which prevailed during this period resulted in coastal predators (fish, birds, mammals) targeting out-migrating juvenile salmonids due to the scarcity of alternative forage fish resources. The so-called "Pearcy Hypothesis" predicts that as ocean conditions improve following the apparent regime shift in 1999, coastal predators on salmonid smolts should shift their attention to other more abundant marine forage fish, thereby enhancing survival of salmonid smolts in the nearshore. We sought to test the Pearcy Hypothesis using data from populations of piscivorous birds in the Columbia River estuary. Beginning in the mid-1980s, numbers of Caspian Terns (Sterna caspia), Double-crested Cormorants (Phalacrocorax auritus), Glaucous-winged/Western Gulls (Larus glaucescens X L. occidentalis), and California Brown Pelicans (Pelecanus occidentalis) all increased dramatically. At the time of the regime shift, the Columbia River estuary supported the largest known breeding colony of Caspian Terns in the world, the largest colony of Double-crested Cormorants on the Pacific coast of North America, and the largest hybrid gull colony and night roost for Brown Pelicans in the Pacific Northwest. This large, multispecies aggregation of piscivorous birds developed synchronously during the positive PDO (late 1980s and through the 1990s). We studied colony size and food habits of Caspian Terns and Double-crested Cormorants during the periods 1997–98 (pre-regime shift), 1999–2000 (regime transition), and 2001–2002 (post-regime shift). Numbers of terns and cormorants, as well as gulls and pelicans, have continued to increase through the regime shift. Despite this, overall avian predation rates on juvenile salmonids in the estuary have declined. After controlling for diet differences among colony sites in the estuary, the proportion of juvenile salmonids in the diet of terns and cormorants declined post-regime shift, compared to the previous two periods. Marine forage fishes (anchovy [Engraulis mordax], herring [Clupea pallasi], sardine [Sardinops sagax], and smelt [Osmeridae]) replaced salmonids in the diet of both species post-regime shift. These results support the Pearcy Hypothesis, that coastal predation on salmonid smolts declined two years after the regime shift and the advent of improved ocean conditions. We hypothesize that the buildup of piscivorous birds in the estuary during the positive PDO reflected the scarcity of forage fish resources elsewhere along the coast, and that the estuary populations may now serve as a source of birds to recolonize other sites along the coast.

Seabird interactions with northern and central California commercial passenger fishing vessels from 1993 through 1998

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In the 1990s, an observer program conducted by the California Department of Fish and Game recorded recreational angler catch information on Commercial Passenger Fishing Vessels (CPFVs) targeting rockfish and lingcod in northern and central California. Between Jan 1993 and Dec 1998, observers also documented any seabird interactions with anglers onboard 1347 CPFV trips. A total of 122 seabirds were recorded as hooked and/or entangled on 4.4% of the observed trips ($n = 59$). California Brown Pelicans (*Pelecanus occidentalis californicus*) accounted for 60% of these gear interactions. Other species included Common Murre (*Uria aalge*; 4%), cormorant species (*Phalacrocorax* spp.; 13%), gull species (*Larus* spp.; 18%), unidentified birds (3%), and one recording each of Pacific Loon (*Gavia pacifica*), Red-throated Loon (*G. stellata*), Northern Fulmar (*Fulmarus glacialis*) and Tufted Puffin (*Fratercula cirrhata*). No direct mortalities were recorded, but in 8% of the events, the lines were cut, releasing the bird with gear attached. The majority of the birds (93%) had hooks removed and/or were disentangled from the gear prior to release. Information will be presented on overall CPFV effort and the annual,

seasonal, and port complex patterns of these interactions.

Modeling the risk of volcanic eruptions on the Short-tailed Albatross population of Torishima

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Eighty-four percent of the world population of Short-tailed Albatrosses (*Phoebastria albatrus*) nests on Torishima, an active volcano that has erupted 3 times in the past 100 years. To evaluate the risk that volcanic activity poses for the population, we developed a simulation model that predicts changes in the population based on the timing and intensity of eruption. Age-specific survival and fecundity values in the model were estimated using field data collected from 1976 to the present. A severe volcanic event occurring during the incubation period of the 2002–2003 breeding season could reduce the current population on Torishima by 40% and the expected population in 25 years by 55%. The world population of Short-tailed Albatrosses in 25 years would be reduced by only 38%, assuming continued 11% annual growth of the Senkaku Islands' population. If a new colony were to be established during the current breeding season, in 25 years its population would represent 0.6% of the world population, assuming no catastrophic events on Torishima. If a severe eruption occurred on Torishima, and bycatch rates at other colonies rose to 10%, the new colony could represent 10% of the world population in 25 years, and 88% of the population in 75 years. We describe the use of the model for exploring other scenarios and guiding management decisions.

Galapagos to BC: seabird communities along a 7800-km transect from the tropical to the subarctic eastern Pacific Ocean

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Studies of seabird biogeography have revealed that species distributions are related to wind conditions and the extent of water masses and ocean productivity patterns over large spatial scales (1000s km). In this paper we document changes in the composition of avifauna in relation to remotely-sensed water mass properties and wind conditions along a 7,800 km transect in the northeastern Pacific Ocean. We analyze a remarkable data set collected during a 48 day (20 Apr–6 Jun 1999) cruise from the Galapagos Islands, Ecuador (0° 43.4' S, 90° W) to Bamfield, British Columbia, Canada (48° N, 124° W) onboard the 13-metre vessel *S/V Minke I.* The dataset comprises 972 seabirds from 34 species, compiled during 485 sightings and approximately 200 survey hours.

We characterized three different marine bird communities: tropical (booby-tropicbird-frigatebird), subarctic (fulmar-albatross) and a widely-distributed, cosmopolitan assemblage dominated by storm-petrels and shearwaters. These communities appear to inhabit distinct regions of the world's ocean characterized by distinct water mass properties (e.g. temperature, chlorophyll). We observed a marked change in species composition at approximately 20° N, with a shift from the tropical to subarctic assemblage. In addition to the latitudinal gradients in community composition, we documented changes in the relative importance of different feeding guilds, namely an increase in the relative abundance of diving seabirds and concurrent decrease in plungers at higher latitudes.

Our results underscored existing evidence of the spatial segregation of species assemblages and feeding guilds in the North Pacific Ocean. Additionally, our study provided an unusual opportunity to survey pelagic seabird distributions within a poorly studied region during an anomalous year. In 1999, wind patterns along the entire cruise deviated from the long-term climatology with a virtual collapse of trade winds typically found below 20°°N. While we lack additional surveys to characterize seabird distributions along the survey track during other years, we speculate on the possible implications of these unusual oceanographic conditions for the large-scale, seabird distributions found. We note several unusual sightings, in particular Northern Fulmars (*Fulmarus glacialis*) below 30° N, and Tufted Puffins (*Fratercula cirrhata*) 675 km west of the Oregon coast.

This presentation highlights the continued importance of ocean exploration and standardized time series for seabird biogeography. In particular, cruises in oceanic regions not regularly visited by marine ornithologists can enhance our understanding of species' ranges. Yet, while single surveys can define different seabird assemblages associated with particular oceanic regions, repeated, standardized surveys are necessary to understand how avifauna respond to temporal variability in ocean conditions. We thus encourage other investigators to retrace this survey track. For more details on the track and methodology, please contact Joanna Smith.

Location, location, location (...and timing): who eats salmon in the mid-Columbia?

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Beginning in the 1930s, historically strong runs of anadromous salmon on the Columbia River declined significantly with the construction of hydroelectric dams. During the late 20th century, fish hatcheries became a major mitigation measure to offset losses in wild populations. Each year, more than 200 million uniquely coded, hatchery-raised salmon are released into the Columbia River. In addition, up to 50 million wild salmon are produced; however, several populations are federally listed as "evolutionarily significant units" because of low survivorship. Many species of birds reside in or enter the Columbia River system after breeding. Terns, gulls and cormorants are large and conspicuous predators implicated as a significant source of juvenile salmon mortality during their seaward migration in the Columbia River; Caspian Terns (*Sterna caspia*) are known to consume up to seven million smolts in the lower Columbia River. However, it is not known what effect these or other piscivorous birds have on juvenile salmon in the mid-Columbia. The objective of this ongoing study is to assess the impacts of avian predators on salmon stocks in the mid-Columbia River. In particular, we are interested in the temporal and spatial patterns of birds in relation to the release of juvenile salmon and the availability of habitat along the river. We conducted weekly boat surveys along 96.5 km of the Columbia River between Rock Island–Rocky Reach Dams and Rocky Reach–Well's Dams, 23 Apr –13 Aug 2002. Salmon that were released from hatcheries were tracked and analyzed with respect to changes in the weekly abundance of avian predators. In 2002, we recorded twelve species of birds on the river, with peak abundance corresponding to prominent physical structures along the river. Survey results were dominated by Common Mergansers (*Mergus merganser*) and Ring-billed Gulls (*Larus delawarensis*)—84 percent of all observations. Caspian Terns, Double-crested Cormorants (*Phalacrocorax auritus*) and California Gulls (*L. californicus*) were infrequent and irregular birds on our surveys—less than 12 percent of observations. Moreover, we found that mergansers were an abundant, resident breeder, present on the river throughout the entire survey period and during the juvenile salmon migration in May and Jun. Ring-billed and California Gulls were relatively uncommon before mid-July, increasing rapidly with a large influx of juveniles and postbreeding adults. Overall bird density was low during the release and out-migration of juvenile salmon (mean 0.85 birds/km), increasing after the salmon had migrated southward beyond this area of the river (mean 4.8 birds/km). We conclude that in 2002, Common Mergansers were the avian predator likely to have had the greatest impact on juvenile salmon in the mid-Columbia River.

Seabird distribution and abundance in the northern Gulf of Alaska in relation to physical hydrography and zooplankton biomass *[Poster]*

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We studied the distribution and abundance of seabird in the Northern Gulf of Alaska, in relation to the distribution of water masses and acoustic measures of water column volume scattering. We surveyed a 200 km transect (inner shelf, mid-shelf, shelf break, and oceanic domains) along the Seward line which starts at Resurrection Bay and runs Southeast across the shelf. This study presents the preliminary results of seabirds surveys conducted during Apr, May, Jul, Aug and Oct 2001 as part of a multidisciplinary study, the Long term Observation Program (LTOP-GLOBEC), in the northern Gulf of Alaska. Seabird distribution, abundance and species composition were related to physical hydrography (temperature, salinity, and fluorescence) zooplankton biomass, and volume backscattering. Stratification increased seasonally due to surface-layer freshening and warming of the shallow mixed layer (~10–20 m). Patterns of seabird distribution and abundance and species composition changed during the survey period. During April, divers and pursuit plungers were most abundant in the mid-shelf and surface feeders predominated at the shelf break, while in May and July divers concentrated on the shelf. During May, Jul and Aug, pursuit plungers and surface feeders were abundant throughout the transect. Gulls and fulmars were mainly concentrated on the shelf and albatrosses were concentrated at the shelf break. During October, overall seabird abundance was low, with fulmars and gulls concentrated on the inner shelf and mid-shelf, respectively. Evolution of the physical properties of the water column in association with changes in zooplankton biomass and volume scattering along the transect suggests that the cross-shelf circulation may have a fundamental role in shaping the distribution and abundance of seabirds.

Phylogeography of *Sula*: the role of physical and nonphysical barriers to gene flow in the diversification of low-latitude seabirds

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Although several genetic studies of high latitude seabird species indicate that both physical (e.g., glaciers) and nonphysical (e.g., divergent selection and/or strong natal philopatry) barriers to gene flow played an important role in the divergence of many populations, similar research on low latitude species is limited. In a previous study, we examined mitochondrial DNA (mtDNA) cytochrome b sequence variation in Masked, Red-footed and Brown Boobies (*Sula*

dactylatra, S. sula, and *S. leucogaster*) sampled from islands in the central and eastern Pacific and Caribbean Sea. Each species presented a unique phylogeographic pattern. Whereas haplotypes in Masked and Red-footed Boobies were shared across the central and eastern Pacific (i.e., across the Eastern Pacific Basin), Brown Booby haplotypes were not. Although most Masked Booby haplotypes from the Pacific were distinct from those in the Caribbean, one haplotype was shared across the Isthmus of Panama.

Red-footed and Brown Boobies, however, did not share haplotypes across the Isthmus of Panama. Thus, the Isthmus of Panama and Eastern Pacific Basin (albeit to a lesser degree) appear to have played important roles in the diversification of these species. More recently, we examined mtDNA control region sequence variation in Masked Boobies sampled from islands throughout their breeding range. Preliminary results suggest that physical barriers alone are unlikely to account for the divergence of several populations. For example, whereas haplotypes were shared between the eastern Indian Ocean and one site in the western Pacific (i.e., on either side of Australia), haplotypes were not shared between two sites within the western Pacific Ocean (i.e., along the east coast of Australia). Thus, it appears that both physical and nonphysical barriers to gene flow played important roles in shaping biogeographic patterns in low latitude seabird populations.

A comparison of seabird colonies in the Bering Sea and Gulf of Alaska

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It can be argued that food is an important factor in limiting seabird distribution and population size in Alaska. Differences in the Bering Sea and Gulf of Alaska allow us to test this statement. Both areas are large and diverse and support millions of breeding seabirds. However, the Bering Sea is more productive (over 50% of all fish captured in the United States come from the Bering Sea) compared to the Gulf of Alaska. We examined the demography of breeding seabirds in the Bering Sea and the Gulf of Alaska using Alaska data from the Beringian Seabird Colony Catalog database. We found the Gulf of Alaska has 1119 colonies and the Bering Sea only 470 colonies. In contrast, the Bering Sea total breeding population and individual colony sizes are larger. Also, most species populations within the Bering Sea colonies are larger. This supports the idea that food is an important factor in regulation of Alaskan seabird colonies.

Response of seabird colonies to predator control at Kaena Point Natural Area Reserve, Oahu, Hawaii *[Poster]*

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Data will be presented demonstrating that control of non-native predators over a three-year period has resulted in a dramatic increase in nesting pairs and fledging success of Wedge-tailed Shearwaters (*Puffinus pacificus*) and Laysan Albatross (*Diomedea immutabilis*) at Kaena Point Natural Area Reserve, Oahu, Hawaii. Dogs, cats, mongoose and rats were controlled using a variety of methods. Lessons learned and recommendations for additional management actions will be presented. Preliminary results from a rat eradication effort on Mokolii Island, Oahu will also be discussed.

Post-breeding season dispersal of Short-tailed Albatrosses and potential interactions with commercial fisheries

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To determine the post-breeding season dispersal routes of Short-tailed Albatrosses (*Phoebastria albatrus*) nesting on Torishima, Japan, satellite transmitters were deployed on 19 albatrosses (primarily subadults) during five years from 1996 to 2002. During each year, albatrosses were tracked between 07 May and 23 Sep, obtaining over 2800 at-sea locations. About half of the transmitter deployments (n = 9) provided data spanning at least two months. In general, Short-tailed Albatrosses exhibited two dispersal patterns. One pattern involved a relatively rapid transit north to the western Aleutian Islands, arriving near Attu by late May or early Jun (approximately 3600 km from Torishima). The second pattern was to stay within the coastal waters (< 250 km from shore) of Honshu and Hokkaido, Japan, and the southern Kuril Islands, Russia, throughout the summer (up to four months); then in early Sep, moving through the Kuril Islands (well within 60 km of shore) and into the western Aleutian Islands. Once in the Aleutians, most birds traveled east toward the Gulf of Alaska, often remain-

ing within 30 km of shore when in passes between Aleutian islands. However, one bird traveled north into the Bering Sea and was near the Pribilof Islands in late Sep. The nearshore and continental shelf regions inhabited by Short-tailed Albatrosses are known to be productive fishing areas. However, publicly accessible data on commercial fishing effort and seabird bycatch are available only for US fleets fishing in the Bering Sea and Gulf of Alaska. Additionally, these are the only fleets known to be using seabird deterrent devices within the range of Short-tailed Albatrosses. Given that albatrosses used nearshore waters off Japan and Russia extensively, it is critical that we also strive to obtain fisheries effort and bycatch data for these regions as well as encouraging the use of seabird deterrent measures. In summary, Short-tailed Albatrosses spent varying amounts of time in different areas of Japanese, Russian, and American waters, signifying the complexity and importance of international collaboration in the at-sea conservation of this species.

Redistribution and growth of the Caspian Tern population along the Pacific Coast of North America: a 20-year assessment of population status

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We examined nesting distribution and demography of the Pacific Coast population of Caspian Terns (*Sterna caspia*) using breeding records and analysis of band recoveries spanning two decades since the first population assessment by Gill and Mewaldt (1983). Since 1980, the number of tern colonies has increased nearly twofold and the population size has more than doubled, reaching nearly 15,000 pairs by 2000. The breeding range of the Pacific Coast population has extended north into Alaska and south into Mexico; however, there was no latitudinal trend in the distribution of new colonies. The distribution of breeding terns among colonies changed dramatically, with 66% of breeding terns now nesting in Oregon (primarily in the Columbia River estuary), compared to only 3% in 1980. There was a continued trend toward abandonment of natural nesting islands and movement to human-created islands, where water levels and prey stocks were relatively stable. Annual survival rates ranged from 0.81 (CI 0.68 to 0.89) for second year to 0.93 (C. 0.84 to 0.98) for third year birds and were generally greater than values reported from 1955–1980. Additionally, there was an increasing trend in adult survival rate throughout the 1980s and 1990s. Productivity estimates required to maintain population stability (lambda = 1) ranged between 0.45 and 0.80 fledglings pair^{-1}. Productivity at colonies in the Columbia River estuary has generally been within or above this range, suggesting that the population may continue to grow. Our results indicate that Caspian Terns readily moved between breeding sites and rapidly colonized new areas; however, anthropogenic factors leading to greater concentration of breeding Caspian Terns among fewer colonies are an important conservation concern for this species.

Hawaii Offshore Islet Restoration Committee to survey and restore seabirds, terrestrial arthropods, and rare coastal plants on islets in the main Hawaiian Islands *[Poster]*

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Survey and restoration plans and initial survey results will be presented for Hawaii's newly formed Offshore Islet Restoration Committee (OIRC). The OIRC is a cooperative, multiagency group that is prioritizing offshore islets in the main Hawaiian Islands for biological surveys and targeting selected islets for restoration, based on biological values, the nature of the treats and feasibility of restoration. The isolation of the islets has made them the last refuge for the majority of seabirds in the main islands as well as several rare and endangered coastal plants. Genetic material from rare plants will be collected and cultured. Restoration actions will include removal of rats, rabbits, invasive weeds and possibly alien ants. Reintroduction of appropriate coastal plants and erosion control will also be considered.

Comparative population biology: oceanographic correlates of seabird survival in the Southern California Current system

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The population dynamics of marine birds is determined by the interaction of seven demographic processes, including: (1) survival or breeding age adults, (2) survival of nonbreeding subadults, (3) age at first breeding (recruitment age), (4) breeding propensity (the probability of breeding each year), (5) emigration rate, (6) immigration rate, and (7) fecundity. Extrinsic factors, e.g., environmental variability and change, and intrinsic factors, e.g., density-dependence, influence each of these demographic parameters, but such effects are very poorly understood (Weimerskirch 2002).

Herein, we report how one demographic process, adult survival (from year^{x} to year^{x+1}), for 3 co-occurring species is influenced by basin scale and local oceanographic conditions. Interannual variability in survival for Brandt's Cormorant (*Phalacrocorax penicillatus*; 1974–2002), Common Murre (*Uria aalge*; 1988–2002), and Cassin's Auklet (*Ptychoramphus aleuticus;* 1982–2002) was modeled using program MARK in relation to the following environmental indices: Northern Oscillation Index (NOI),Southern Oscillation Index (SOI), Multivariate El Niño Index (MEI), sea-surface temperature (SST, on site), and Bakun's Upwelling Index (UI, averaged for 36° N to 39° N). Indices were developed for the fall-winter period each year. All species showed reduced survival during El Niño months, but the degree of change varied with each event. Oceanographic relationships were strongest for the auklet, with 66% of the variance explained by the SOI, and weakest for murre, with 12% of the variance explained by the NOI. Cormorant survival was related to local SST (24% of the variance explained). Results indicate that the adult survival of these species is determined by mechanisms operating on multiple temporal and spatial scales. This highlights the important role of environmental variability in controlling seabird populations in this ecosystem.

Integration of marine bird and mammal observations with the EastWest Continuous Plankton Recorder Project *[Poster]*

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A multi-decadal program to sample subsurface plankton along a 7,000 km east-west trans-Pacific route began in 2000. In May of 2002, under the auspices of the North Pacific Research Board, we initiated a project to integrate marine bird and mammal (MBM) observations with continuous plankton recorder (CPR) sampling. Two transects have been completed thus far (May–Jun, Sep–Oct), with three more planned for 2003 (Mar–Apr, May–Jun, Sep–Oct). Our short-term goals are to: (1) develop standardized MBM survey methods for large and high-speed (~20 knots) voluntary observing ships (VOS), (2) characterize seasonal variation in MBM communities associated with water masses and transitions zones in the North Pacific Ocean and south Bering Sea during 2002–2003, and (3) assess the spatial coherence between zooplankton and MBM abundance, and species assemblages. Preliminary results indicate that quantitative MBM observations are feasible from VOS, by slightly modifying standard survey methodologies using detection functions of perpendicular distance from the trackline to account for changes in species identifications. Using these modified survey methods, approximately 112,000 MBM were observed during the May–Jun survey, with almost 90% being dark shearwaters (Sooty and Short-tailed Shearwaters *Puffinus griseus* and *P. tenuirostris*). MBM assemblages varied in abundance, composition and diversity between the Gulf of Alaska, southern Bering Sea, and the Oyashio/Kuroshio (western North Pacific) regions. Our long-term goal is to study changes in MBM assemblages, predator-prey habitat associations, and ecosystem linkages (phasing and transitions) in the North Pacific Ocean, relative to climate variability on multiple temporal scales. This information will provide resource managers and policy makers with a better understanding of the spatial and temporal dynamics of marine species distributions and the predictability of wildlife-habitat associations in oceanic systems.

Organic and heavy metal contaminants ion eggs of Caspian, Least, and Forster's Terns from western United States colonies *[Poster]*

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Concentrations of contaminants have been measured for decades and used as meaningful indicators of the relative health of populations of various species, and the ecosystems in which they live, across both space and time. The goal of this study was to assess aspects of the current health of nearshore coastal marine waters of the western United States by measuring various organic and heavy metal contaminant levels in appropriate trophic-level species Seabirds are a particularly useful group of species to assess ecosystem health at various temporal and geographic scales, because many species feed at high trophic levels, are long-lived, and typically are faithful to their breed sites. Therefore, in this study, we measured some heavy metal and organic contaminants in three upper trophic level obligate fish-eating seabirds (Forster's, Least and Caspian Terns [*Sterna forsteri, S. antillarum,* and *S. caspia*]) at various colonies along the west coast of the United States. Our goals were to assess differences in contaminant levels among different geographic breeding populations and to compare these levels to historical contaminant data for these species. Specifically, we measured various polychlorinated biphenyls

(PCBs), organochlorines, dioxins, a relatively new class of compounds of concern known as polybrominated biphenyl ethers, and three heavy metals (mercury, arsenic and lead). These data will be presented and discussed.

Avian interactions with offshore wind turbines in Europe: a survey of current knowledge

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Large-scale offshore wind energy development is already proceeding in Europe. Both the European Union and the individual countries have developed study requirements to characterize avian interactions. Studies are required to consider both behavior (exclusion, flight interference) and collision mortality. Preliminary results from some studies show low levels of turbine-related mortality affecting several different groups of birds. These include both sea birds and land birds (particularly at near-shore installations). Mortality may be associated with periods of restricted visibility. However, it is too early in the development of large offshore wind installations to establish definitive causal relationships. Studies also show some behavioral avoidance of the immediate vicinity of the turbine groups. Additional studies of larger installations may confirm this trend, or reveal other impacts that may bear on offshore wind development in North America.

The murrelets can't wait—timeliness versus science

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Marbled Murrelet (*Brachyramphus marmoratus*) are small seabirds that live along the Pacific coast. They nest in old-growth forests. Marbled Murrelets are still relatively abundant, but they are threatened because populations are declining, probably due to loss of nesting habitat. The Forest Practices Board is a public watchdog in British Columbia (BC). It reports about the soundness of management of forest resources. The Board examined the designation of wildlife habitat areas to protect old growth nesting habitat from forest practices. The Board found that potential habitat areas are being lost to forest development while protection was being considered. That loss has happened rapidly. Somewhere between 25 and 44 per cent of potential habitat for Marbled Murrelets that was available in 1995 was gone by 2001 on BC's south coast, due to logging and roads. The Board has concluded that the provincial forest practices legislation has not been effective. The designation process is cumbersome. There is no incentive to designate wildlife habitat areas; the incentives are to delay. Opponents stress the many unknowns about what makes good nesting habitat.

The Board points out that resource managers cannot wait until researchers learn all that must be known about what Marbled Murrelets need for nesting, or exactly where those nests are, to protect this species. The murrelets can't wait for science. Government has to designate interim wildlife habitat areas quickly, using the best available information. Otherwise, conservation options are being logged and lost at a startling rate. Nevertheless, protected area boundaries should be refined promptly so that areas not needed by Marbled Murrelets can be utilized. That requires incentives for government and industry to use practical science.

Kittlitz's murrelets along the south coast of the Kenai Peninsula, Alaska: distribution, abundance, and trend estimation *[Poster]*

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The Kittlitz's Murrelet (*Brachyramphus brevirostris*) is a rare seabird that nests in alpine terrain and generally forages near tidewater glaciers during the breeding season. Because Kittlitz's Murrelet nest sites are widely dispersed and notoriously hard to find, and at-sea behavior is difficult to study, very little is known about the natural history and ecology of this species. More than 95% of the global population is estimated to breed in Alaska, with the remainder occurring in the Russian Far East. A global population estimate using the best available data in the early 1990s was 20,000 individuals. However, survey data from two core areas (Prince William Sound and Glacier Bay) show 80–90% population declines during the past 10–20 years. In response to these declines, a coalition of environmental groups petitioned the U.S. Fish and Wildlife Service in May of 2001 to list the Kittlitz's Murrelet under the Endangered Species Act.

Although the status and trend of Kittlitz's Murrelet populations are reasonably well understood in Prince William Sound and Glacier Bay, very little is known about populations elsewhere in their range. The true magnitude of this apparently broad-scale decline therefore remains unknown, complicating effective management of the species. In response to this information gap, we surveyed the coastal and pelagic waters along the southern coast of the Kenai Peninsula (centered on Kenai Fjords National Park) during July 2002, in the first year of a planned three-year study examining distribution and abundance of Kittlitz's Murrelets in poorly-known areas that are expected to support significant populations. Numerous tidewater glaciers and glacial freshwater outflows influence the marine ecology of the Kenai Fjords region, and some comparative historical data are available. We present distribution maps and population status and trend estimates, and we discuss our results in the context of Kittlitz's Murrelet ecology, survey design, and conservation.

Tail streamer function and sexual selection in t he Red-tailed Tropicbird, *Phaethon rubricauda*

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We investigated the function of Red-tailed Tropicbird tail streamers by quantifying patterns of variation in streamers and related morphological traits based on measurements of 658 individuals (including 422 known age and 459 known sex) during 2000–2002. Our data are consistent with the idea that tail streamer ornaments function for mate attraction, but suggest that variability in their expression is arbitrary and unlikely to provide a meaningful signal of individual quality during mate choice. The elongated, bilaterally symmetrical red tail streamers averaged 398 ± 1.8 SE mm in length when fully grown. Prior to breeding adults of both sexes displayed two fully grown streamers to the opposite sex during aerial courtship. Streamers molt alternately, with adults displaying at least one fully grown streamer throughout the year. As in other putative sexually selected traits, tropicbird ornaments were more variable than non-ornamental traits. Males were slightly larger than females with evidence for slight sexual dimorphism of streamer, culmen, and tarsus lengths. There was no correlation between streamer length and body size or wing length consistent with the hypothesis that streamers have an ornamental rather than aerodynamic function. There was a correlation between the ratio of streamer lengths of male and female pair members indicating that ornament expression is synchronized within pairs. Based on adults (3–22 years), streamer length did not increase with age and streamer length was not correlated with an index of body condition or breeding performance.

Effects of the eradication of introduced rodents on the seabirds breeding in Isla Rasa, Gulf of California, México

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Black rats (*Rattus rattus*) and house mice (*Mus musculus*) were introduced in Isla Rasa around the late 19th century. Isla Rasa is the main nesting site of Heermann's Gulls (*Larus heermanni*) and Elegant Terns (*Sterna elegans*) (95% of the world populations of both species nest there), and it was reported to be a nesting site for Craveri's Murrelets (*Synthliboramphus craveri*). This latter species is now absent from the island and is believed to have been extirpated by the introduced rodents. During 1995 we carried out an eradication program on both rodent species using Talon; we placed the baits in 10-inch pipes and 2-inch pipes (baiting stations), for rats and mice respectively. Both rodents were totally eradicated in less than two months. During two subsequent years we conducted surveys of the breeding success of the gulls on the island and compared it to that of years previous to the eradication of the rodents. Rasa Island mainly consists of valleys surrounded by rocky hills. During the time the rats were present on the island, survival of chicks under a week of age was five times lower in the rocky areas compared to that of the valleys. After the eradication the gulls nesting in the valley areas, where rats were relatively scarce, kept the same breeding success. However, on the rocky hills, were rodents were prevalent, the breeding success of the gulls increased fivefold after the eradication. This increase in breeding success was due to the increase in the survival rate of newborn chicks. The effect on the Elegant Tern colony was a dramatic increase in the number of breeding pairs successfully establishing in the nesting colony. From some 25,000 in the late 1980s the number of nesting pairs increased to close to 100,000 in the late 1990s. Qualitative observations have shown an increase in House Finches (*Carpodacus mexicanus*) on the island, and in the density of some intertidal invertebrates. Also, the Peregrine Falcon (*Falco peregrinus*) pair has changed its nesting site from a cliff to lower ground.

A comparison of Common Murre breeding performance at previously used and newly established sites on Devil's Slide Rock, California *[Poster]*

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We compared reproductive success and phenology of Common Murres (*Uria aalge*) at previously used and newly established breeding sites on Devil's Slide Rock, California, from 1996 to 2002. Since 1996, social attraction equipment has been used at Devil's Slide Rock to restore a previously extirpated breeding colony of murres. New and reused breeding sites were documented each year through the use of land-based observations, on-site GPS locations, and aerial photographs. All potential murre breeding sites on the rock were monitored each year and ranged from 12 (6 egg-laying) in 1996 to 218 (123 egg-laying) in 2002. We examined patterns of site use between years and found that successful breeding sites were more likely to be reused the following year. Results also demonstrate that mean laying dates were earlier at previously used sites than newly established sites, though the differences between the two groups varied between years. The number of chicks fledged per pair was consistently higher at reused sites than at new sites, a difference that can be attributed to higher hatching suc-

cess at returning sites. Fledging success was variable between the two groups but was usually higher at previously used sites. The earlier phenology and higher breeding success at previously used sites suggests continued use by experienced breeders, thus implying high breeding-site fidelity in DSR murres.

Development of adrenocortical stress response in free-living Magellanic Penguin chicks: effects of food deprivation and tourist disturbance

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In nest-bound chicks that are unable to defend themselves or avoid noxious stimuli, a robust adrenocortical stress response shortly after hatching may be costly due to detrimental affects of a prolonged secretion of corticosterone. Thus, nest-bound chicks may delay the development of the adrenocortical stress response until near fledging. As well, the development of the stress response in chicks may be affected by such aspects as dietary restriction (i.e. quantity or quality of food) or repeated disturbances (i.e. tourist visits to nesting areas). Here, we report the development of the stress response in free-living Magellanic Penguin (*Spheniscus magellanicus*) chicks, and the adrenocortical function of chicks within a brood in relation to body condition. We also compare how chicks raised in tourist visitation areas compare to those raised in undisturbed areas of the breeding colony. Healthy, normally developing penguin chicks showed little glucocortical response to capture stress shortly after hatching, an intermediate response around 45 days post-hatch, and a robust adult-like stress response near fledging. The larger sibling in broods of two showed the same pattern, as expected for healthy chicks. In contrast, by day 45, when differences in body condition were well established between siblings, the smaller, food deprived chicks significantly increased baseline levels of corticosterone, but showed normal stress induced levels. Near fledging, baseline levels had returned to normal, but stress-induced levels were lower than expected for undisturbed chicks. In tourist-exposed chicks, stress responses early in development were higher than non-disturbed chicks. However, near fledging, there was no differences between tourist and undisturbed chicks. These results show that Magellanic Penguin chicks do not develop a robust glucocortical stress response until near fledging. However, food-deprived chicks appear to increase the rate of development early on, but down-regulate their stress response late in the season. For food deprived chicks, this may be a mechanism to avoid the effects of long-term elevation of glucocorticoids. However, it appears that those chicks which are raised in tourist-exposed areas are subjected to some modulation in the development of their stress-response to disturbance. Whether this modification is an artifact of parental conditioning to tourist disturbance is unknown.

Population and conservation genetics of Black-footed Albatrosses (*Phoebastria nigripes*): provenance of fisheries bycatch assessed using genetic markers

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Recent population declines have colored the demographics of many large pelagic seabird species. The largest of the seabirds are albatrosses (Procellariiformes: Diomedeidae) and presently, many albatross species exhibit decreasing population numbers. Though the causes of population declines are manifold (interaction with fisheries, exposure to environmental contaminants, historical poaching, habitat loss etc.), a thorough understanding of the population genetics of a species can inform conservation measures. DNA markers are being used to obtain information on long-term effective population sizes, regional differentiation among colonies, and rates and directions of gene flow for Black-footed Albatrosses (*Phoebastria nigripes*). Using these markers, archived bycatch specimens are being screened to estimate the proportion of the Black-footed Albatross fisheries bycatch that is derived from each of the major breeding colonies of this species.

Modeling individual variation in the Western Gull

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Current population viability analysis models may overlook individual variation in survival and fecundity. As variation in survival probability increases, demographic stochasticity is expected to decrease. Variation in fecundity may have varying effects on demographic stochasticity, depending on the species modeled and the mean-variance relationship of the fecundity data. I tested ways in which variation in survival and fecundity may be incorporated into population models of the Western Gull (*Larus occidentalis).* The models were based on lifetime reproductive success data obtained by researchers at Point Reyes Bird Observatory, Conservation Science, for a cohort of Western Gulls on Southeast Farallon Island, California. To explore variation in survival, I compared stochastic models using normal vs. binomial distributions for survival rates and a normal distribution for fecundity. To explore variation in fecundity, I compared models using normal, beta, uniform, and actual distributions for fecundity and a binomial distribution for survival rates. The fecundity models using normal and beta distributions consistently underestimated lambda values and predicted population sizes at years 25, 50, 75, and 100, compared to the model with the actual distribution of fecundity data. The fecundity model using a uniform distribution, on

the other hand, consistently overestimated lambda values and predicted population sizes. The study highlights the importance of incorporating empirically supported distributions of demographic data into population models, instead of assuming distributional shapes.

A landmark-based morphometric analysis of the pelecaniform pectoral girdle: characters and the study of adaptive evolution

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During the past two decades, studies of adaptation have moved from an ahistorical analysis of form and function to historical investigations that proceed first from phylogeny reconstruction and character evolution. During this same time period, there has been a revolution in the study of morphometrics, "the description and statistical analysis of shape variation" (Rohlf and Marcus, 1993). The focus of this "new morphometrics" is the geometry of form and the orientation of two- or three-dimensional coordinates or landmarks, in contrast to the more traditional linear distances or measurements. The goal of this talk is twofold. First, I will introduce shape characters of the pelecaniform pectoral girdle (sternum, coracoids, and furcula or clavicle), using the language of landmark-based morphometrics. These characters are a decomposition of general shape into principal components, and are based on a constellation of skeletal landmarks indicating the positions of muscle or ligament attachments. Second, I will offer a method by which these morphometrically-defined characters can be described and presented for analyses relevant to the study of adaptation. Elements of the pectoral girdle are the origin of the *M. pectoralis* and *M. supracoracoideus*, the primary muscles responsible for the down- and upstroke of the avian wing, respectively. I will not test specific hypotheses of adaptation because I will not introduce any aspect of selective regimes or performance advantages. However, in the context of phylogenetic hypotheses, I will present how the morphometry of the pectoral girdle can be used in a study of adaptation to specific foraging methods in the Sulidae.

Dammed fish and damned birds: avian predation in the mid-Columbia

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Salmon in the Northwest Pacific are an important commercial and cultural resource, and much effort is spent to halt declines occurring in most stocks. On the Columbia River, salmon are faced with a variety of obstacles, not least of which is the presence of 10 dams on the main stem of the river alone. In the mid-Columbia, dam operation is conditional on a mortality limit of salmon smolts per dam. This limit has been imposed by the National Marine Fisheries Service as part of a Habitat Conservation Plan with Chelan County, which operates Rocky Reach and Rock Island dams. Less than 20% of tagged salmon released above Rock Island Dam were detected at the passive integrated transponder (PIT) tag reader at McNary Dam.

What caused this loss, and what can be done about it? Smolt mortality can be reduced by increasing outmigrant migration rate or decreasing predator pressure. Whereas the former is extremely expensive, the latter is cheap. Thus, in order to maintain these salmon-passage quotas, dam operators have resorted to lethal and non-lethal control of both piscine and avian predators, which are thought to concentrate their efforts just below the dams (in the tailraces). Avian predators of concern include Ring-billed and California Gulls (*Larus delawarensis* and *L. californicus*), Double-crested Cormorants (*Phalacrocorax auritis*), and Caspian Terns (*Sterna caspia*).

In the first year of a three-year study, we investigated the spatial and temporal abundance and foraging behavior patterns of avian predators at Rock Island and Rocky Reach dams on the mid-Columbia River during summer 2002. The Rock Island aquatic bird community was dominated by Great Blue Herons (*Ardea herodias*) during May and Jun and by cormorants in Jul and Aug. Gulls and mergansers (*Mergus* spp.) were the dominant species at Rocky Reach. Abundance peaked at both dams late in the season, and was associated with an influx of subadult and especially juvenile birds. Birds were consistently more abundant above the dams (forebay), rather than in the tailraces, where disoriented salmon smolts were thought to occur. Interestingly, control regimes—including shooting and noise deterrents—were ineffective in reducing either bird abundance or attack rates. Despite the nefarious reputation of terns in the lower Columbia, attack rates (attacks/bird/hour) in the mid-Columbia were highest for herons, followed by cormorants and mergansers. Neither abundance nor attack rates showed any relationship with salmonid availability, although the high peaks of salmonids in the river early in the system occurred before the start of this study. Of the over 80% tagged fish lost between release sites and McNary dam, less than 0.01% (30) were found in birds shot at Rock Island Dam. In sum, avian predators observed at Rock Island and Rocky Reach dams in 2002 do not seem to have contributed much to salmonid mortality in the mid-Columbia river.

Human influences on whiskered Auklet distribution and abundance through time

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The Whiskered Auklet (*Aethia pygmaea*) is a small alcid endemic to an arc of volcanic islands formed by the Aleutian, Commander, and Kurile island chains. It is commonly thought to be much rarer and less colonial than its abundant congeners the Crested Auklet (*Aethia cristatella*), Least Auklet (*Aethia pusilla*), and Parakeet Auklet (*Aethia psittacula*). Little was known about the biology, distribution, and abundance of the Whiskered Auklet until the 1990s, when several directed studies were conducted. Research indicated that, almost uniquely among alcids, many young return to the breeding colony for at least a month, and possibly longer, after fledging. Nocturnal at the colony, significant numbers of unwary adults could also be found sleeping on the surface of colonies after the breeding season. We suggest that this unique behavior disposed Whiskered Auklets to excessive predation when non-native arctic foxes (*Alopex lagopus*) were introduced for the purpose of fur farming. This excessive predation radically affected Whiskered Auklet population abundance and distribution.

The Aleutian Islands have no native terrestrial mammals west of Umnak Island. Avifauna evolved in this environment free of mammalian predation. Widespread introductions of arctic foxes beginning in 1750 were successful because foxes preyed on the large numbers of seabirds. Introductions reached their peak from 1910 to 1940 when nearly every island had non-native arctic foxes. Beginning in 1949, the Alaska Maritime National Wildlife Refuge began eradicating foxes from refuge islands. By 2002, the refuge had removed foxes from 40 islands, restoring approximately 1800 miles of coastline or 1,000,000 acres.

It is possible to describe changes in relative abundance of Whiskered Auklets over time and speculate on causes. We suggest that Whiskered Auklet were formerly abundant prior to fox introductions, experienced large declines at the peak of fur farming, and are now recovering after fox removal. Early naturalists such as Turner in 1886 reported Whiskered Auklet as "quite abundant" in the Near Islands group of the Aleutians and "common" at locations in the central Aleutians when fox introductions were beginning. By 1936, when fox introductions to islands were at their peak, Olaus Murie noted that Whiskered Auklets had disappeared for the Near Islands and were becoming scarce elsewhere. He estimated only a few thousand birds bred in the Aleutians. Surveys by Byrd and Gibson in the 1970s indicated that there were about 25,000 birds. By 2002, observations indicate single flocks can now be larger than Byrd and Gibson's population estimate. We propose that management actions of the Alaska Maritime National Wildlife Refuge were responsible for these changes in abundance and distribution and will discuss future trends.

Ecology of Common Eiders on the Yukon-Kuskokwim Delta, Alaska *[Poster]*

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Indices of Pacific Common Eider (*Somateria mollissima v-nigrum*) populations in western North America have declined by approximately 50% in the past 25 years and the species is currently considered "at risk" by U.S. Fish and Wildlife Service (Region 7). Historically, the Yukon-Kuskokwim Delta (YKD) has been the primary breeding area for Common Eider in Alaska. Survey data now suggest a >90% reduction in breeding eiders on the YKD over the past 40 years (1957–1998)—a decline from 51,000 to 2300 nesting pairs. Since 1992, the Yukon Delta National Wildlife Refuge and Alaska Science Center have collected data on common eider reproduction and survival in conjunction with ongoing waterfowl studies on the YKD. However, nest monitoring and mark-recapture efforts were not consistently replicated across study areas and no detailed analysis of historical data, barring duckling survival, was conducted.

In 2002, we began a study examining the survival and reproduction of Common Eiders on the YKD. We initiated replicate monitoring and mark-recapture efforts at Kigigak Island and Tutakoke River study sites with the goal of combining historic and recent data into a common eider population model for the YKD. Specific project objectives include estimating annual and geographic variation in nesting success and adult female survival and examining factors influencing these life-history parameters. We report preliminary results from the 2002 breeding season, including geographic variation in nest initiation dates, nesting chronology, clutch size, and nest success. In 2002, we located 203 nests at Kigigak Island and 131 nests at Tutakoke River. Of these, 167 and 93 survived into incubation, such that we could determine both clutch size and nest initiation date. Nests were initiated earlier at Kigigak Island than at Tutakoke River. Average clutch size (5.1 ± 0.08 SE) did not vary between the two locations after controlling for initiation date. Clutch size declined through the nesting season at a rate of –0.093 (± 0.01 SE) eggs per day, at both locations. We based nest success on nest survival models allowing daily nest survival rate (DSR) to vary by location, nest age, and initiation date. Nest success declined with nest age and initiation date and varied by site. Estimated overall nest success (early to late initiation) ranged from 61 to 46% at Kigigak and 53 to 38% at Tutakoke. The 2002 data indicate that nest success for Common Eider on the YKD varies by geographic location. If differences in overall productivity (duckling production) are consistent across years, managers may want to consider

the two locations as sub-populations, but this will depend on the results of the multi-year analyses.

Concentrations of trace elements in blood of Spectacled and King Eiders in northern Alaska *[Poster]*

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In 1996 we measured concentrations of arsenic, barium, cadmium, lead, mercury, and selenium in the blood of King and Spectacled Eiders (*Somateria spectabilis* and *S. fischeri*) breeding in northern Alaska, USA. We sampled adults from both species and duckling spectacled eiders. In spectacled eiders lead was found at levels consistent with clinical toxicity. In both spectacled and king eiders, selenium was also found at high levels compared to concentrations considered toxic in freshwater birds. However, the significance of these high selenium levels for eiders is still unclear. Concentrations of cadmium and mercury varied between species, and concentrations of barium, cadmium, mercury, and selenium varied between sexes. Elevated lead levels in one duckling and two adult female spectacled eiders suggest that lead was available on the breeding grounds. Mercury concentrations were positively correlated with date, and detectable mercury was found in 100% of Spectacled Eider adults and 42% of ducklings. This suggests that mercury was also available on the study area. Barium and selenium levels decreased through the breeding season and selenium declined at 2.25% ± 0.9% per day. Selenium levels were lower in eiders arriving to the breeding grounds in northern Alaska than in western Alaska. Eiders wintering in the Bering Sea are likely exposed to similar levels of local selenium, but northern breeding eiders may have more opportunity to eliminate selenium during their longer spring migration and use of different spring staging areas. Most trace elements and heavy metals for which we tested were not at concentrations currently considered toxic to marine birds. However, potential exposure to mercury and lead on the breeding grounds warrants further attention.

Windows of opportunity: do biophysical drivers influence prey availability to marine predators? *[Poster]*

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Ocean physics dictates the spatial and temporal distribution of nutrients and associated biomass, thus playing a key role in predator-prey dynamics in marine ecosystems. We take a bottom-up approach, identifying physical drivers of prey availability to top marine predators in the North Sea. Our model system is a pursuit diver, the Common Guillemot, *Uria aalge*, which feeds on small shoaling fish, primarily lesser sandeels *Ammodytes marinus* and sprats *Sprattus sprattus* in our study area. We used data from depth loggers attached to diving Common Guillemots, together with tidal current speed, to investigate effects of tidal state on foraging behavior. Our results show that the birds were diving deepest during peak flood currents and shallowest during peak ebb currents. We suggest this pattern may be due to direct effects of tidal turbulence on fish distributions in the water column. Turbulence is caused by friction as tidal currents move across the ocean floor and its strength is driven by current speed and bottom depth and aspect. Prey may move upwards during periods of high turbulence, either passively or actively, into areas where turbulence is reduced, and our diving data from Common Guillemots suggests they may be tracking the vertical distribution of fish prey caused by the effects of turbulence. Alternatively, high turbulence may be an unfavorable foraging environment, and shallower diving may reflect predator avoidance of turbulence. In our study area, the birds may have been feeding on the southern edge of a bank, such that turbulence caused by the (northerly) ebbing tide was strong, whereas the same location would be largely protected from turbulence during the (southerly) flooding tide. Thus, tidal state and bathymetry appear to be important in dictating the foraging decisions of Common Guillemots.

A major new roost site for endangered California Brown Pelicans in the Columbia River estuary

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The 1983 Endangered Species Recovery Plan for California Brown Pelicans (*Pelecanus occidentalis*) emphasized the role of roost sites in restoration of this subspecies. Since then, more attention has been given to identification and protection of these sites. East Sand Island, a 21-ha island located near the mouth of the Columbia River estuary, recently became a major roost site for California Brown Pelicans during the postbreeding period. Annual high counts of Brown Pelicans roosting on the island during 2001 and 2002 were 4434 and 10,852 pelicans, respectively. During the early 1980s generally less than 50 California Brown Pelicans used East Sand Island; numbers increased gradually over

the next 15 years. Following the ocean regime shift in 1999, numbers of California Brown Pelicans using East Sand Island increased dramatically, coincident with the return of large numbers of marine forage fish to the estuary. We investigated factors affecting pelican numbers and distribution on East Sand Island from May to November in 2001 and 2002. In both years, pelicans first arrived in early May and roosted on the west jetty, adjacent to a large nesting colony of Double-crested Cormorants. Early-arriving adults and subadults engaged in much breeding behavior, including courtship, nest-building, copulation, and broodiness, suggesting that nesting may occur in future years. As pelican numbers increased seasonally into the 1000s, they spread out and roosted throughout the island's beaches. Most pelicans had departed the island roost by late November. We examined factors affecting the numbers of pelicans roosting on East Sand Island, including weather, tides, and natural and anthropogenic disturbances. We determined that tide stage, time of day, temperature, and, to a lesser degree, cloud cover affected numbers of pelicans on the island. Bald Eagles (*Haliaeetus leucocephalus*) were the cause of most natural disturbances to pelicans on the island. Although anthropogenic disturbance, including research activities, caused declines in numbers of pelicans using areas near a disturbance source, these effects were short-term and did not appear to affect the total number of pelicans using the island.

The diet of Brandt's Cormorants breeding and foraging in an estuary *[Poster]*

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The Brandt's Cormorant (*Phalacrocorax penicillatus*; BRAC), a marine bird endemic to the California Current system, began breeding on Alcatraz Island in San Francisco Bay, California, in 1990. Since this time, the number of breeding birds has steadily increased and there has been relatively high productivity at that site to the present. Typically a coastal and nearshore species, BRAC have begun foraging within San Francisco Bay during the breeding season in large numbers, including those that breed on Alcatraz Island. The goal of this study is to examine the diet of BRAC breeding on Alcatraz to attempt to answer the question of how and why this species is able to thrive and breed successfully in the estuarine environment of the bay. To address this, 60 to 120 regurgitated cormorant pellets were collected on Alcatraz in late summer between 2000 and 2002 at both colony and roosting sites. The analysis of fish otoliths present within the pellets provides the following data: (1) the diet composition in terms of the fish species consumed and the relative frequency of each, an (2) the average sizes and/or age classes taken of each principal prey species. As previous studies have indicated BRAC to be opportunistic foragers in the lower portions of the water column and benthic zones, we expect the diet composition of the Alcatraz birds to largely reflect the assemblage of common species known to exist in these same habitats with the portions of the Bay surrounding Alcatraz, such as sculpins, sanddabs (*Citharichthys* sp.), midshipman (*Porichthys* spp.), northern anchovy (*Engraulis mordax*), and juvenile rockfish (*Sebastes* spp.) We also anticipate that the average age class of fish susceptible to predation by BRAC will vary between fish species, as prey selection by BRAC will be in part determined by the size of the prey. Results thus far have found that the diet of Alcatraz BRAC during the study years consisted mostly of sanddab sp., northern anchovy, plainfin midshipman (*Porichthys notatus*), and spotted cusk-eel (*Chilara taylori*). This study will be an important contribution to the current knowledge on BRAC diet because the nature of the breeding and foraging environment is unusual for this species, and few studies have quantified the specific age and size of prey taken by BRAC.

Bathymetric associations underlying marine bird and mammal dispersion in central California

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Studies of marine birds and mammals (MBM) at sea have mainly focused on hydrographic habitat associations, although there are some notable exceptions (e.g., seamounts and shallow banks in otherwise deep-water regions). Shallow-water topographies (i.e., bathymetry) influence small-scale currents, giving raise to convergence and upwelling zones, which in turn provide enhanced foraging opportunities for upper-trophic marine predators. We used replicate seasonal surveys of MBM, conducted in conjunction with National Marine Fishery Service Rockfish Recruitment Studies cruises in the Gulf of the Farallones (central California) during May–June 1996–2002, to examine the relationships between MBM distributions and bathymetric features, including the shelf, shelf break, slope, seamounts and submarine canyons. Our objective was to characterize bathymetric habitat "hotspots" of top predator aggregation in this region of the California Current. We concentrated our analyses on the 12 most abundant species observed during our surveys, and used concordance analyses of multiple regression results (i.e., the repeatability of species dispersion and bathymetric associations in time and space) to infer the relative importance of bathymetric variables to habitat selection. Some species were found to have persistent associations with certain features (e.g., water depth, distance to specific isobaths, seafloor slope and variability) while others showed no clear patterns. These results were supported by indepen-

dent analysis conducted using repeated surveys within and across years. Because static topographic features likely interact with water flow to promote predator-prey aggregations, future studies will quantify top predator distributions with respect to bathymetric and hydrographic habitats concurrently.

Local oceanography explains the presence of deep-water fish in Common Murre chick diets

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Select prey species delivered to chicks by parent Common Murres (*Uria aalge*) at Tatoosh Island, Washington normally occupy deep habitat beyond which murres can forage, such as that found in canyons and beyond the shelf break. In particular, murres occasionally return with myctophids, which are deep-water (200+ meters), diel vertical migrators that come to the surface at night. Because murres are diurnal foragers, we assumed that the presence of these fish in the chick diet signal a potential biophysical mechanism which transported and trapped these fish on the shelf during daylight hours. Our goal was to develop a model of the physical oceanography that could explain the presence of deep-water fish in the murre chick diets. We recorded the daily diets of murre chicks (1997–2002) and used the presence or absence of deep-water fish as our response variable in a logistic model. We then examined the influence of oceanography by using proxies for the major forcing factors in the system as independent variables. Variables representing winds, tides, and remote forcing (Pacific Decadal Oscillation; PDO) were highly influential in predicting the presence of deep-water fish. Other studies have attempted to show relationships between physical processes and upper trophic species, but these relationships are often confounded by multiple nonlinear relationships between trophic levels.

We believe our model proved successful for 3 reasons: (1) the model does not assume linear relationships, (2) the model integrates 3 explanatory variables, versus a one to one correlation analysis, and (3), the proposed mechanism is fairly simple, i.e., the confluence of physical factors directly influences how the fish come to be within foraging range.

Combining GIS and Landsat data to study habitat selection by nesting Marbled Murrelets in relation to forest patch size and distances to edges in Desolation and Clayoquot Sounds, British Columbia, Canada

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Habitat associations of the Marbled Murrelet (*Brachyramphus marmoratus*), a small Alcid that nests in old-growth forests of the Pacific Northwest, became a topic of great interest when the species received designated conservation status in Canada and the US. Here we report on site selectivity of murrelets based on 121 nest sites found in a fragmented forest landscape of Desolation Sound (DS), in 1998–2001, and on 36 nest sites from Clayoquot Sound (CS),where the forest is more intact, from 2000 to 2002. We captured and radio-tagged murrelets on the water, and subsequently located nests during aerial searches during the birds' incubation periods. At DS, we investigated the influence of the following landscape features on nest site selectivity: (1) size of the forest nest patch, and distances to the edges of (2) the nest patch per se, (3) nearest hard-edge clearcut, (4) nearest fuzzy-edge clearcut, (5) nearest logging road, (6) stream, (7) lake, (8) subalpine area, (9) glacier, and (10) ocean shore. Clearcut information was obtained from a recent Landsat image, on which these features were classified as clearcuts proper (hard-edge) and areas comprised of clearcuts, remnant old-growth and regenerating young forest (fuzzy-edge). All the other data were obtained from 1:20,000 and 1:50,000 GIS maps. Variables (1) and (2) were also evaluated on the smaller CS sample. We defined a patch as a contiguous forest area, within the appropriate age category (>140 yrs), delimited by streams and roads, as opposed to using botanical polygon boundaries. We believe that patches defined in this fashion best represent the real-life habitat configuration.

The distributions of patch size and distance-to-patch-edge characteristics of nest sites were compared to randomly selected locations ($n = 1072$) in a 50-km radius circle centered at the aquatic capture site, for each study area. Distances to the other landscape features were compared to 5 sets of random samples.

In DS, murrelet nests fell into old-growth patches significantly smaller (mean 169 ± 295.0 ha, $n = 65$) than would be expected by chance (185.9 ± 294.2 ha, $n = 1072$) (goodness-of-fit $\chi^2 = 33.3$, df = 8, $P < 0.001$). No size-dependent patch selection was detected in CS, where mean forest patch size is substantially larger (nest, 657.4 ± 879.5 ha, $n = 31$; random, 709.4 ± 939.8 ha, $n = 1072$; goodness-of-fit $\chi^2 = 9.9$, df = 8, $P = 0.28$). In CS, 60% of both nest sites and random points fell within 90 m of the patch edge. In DS, an area with substantially more fragmented forest cover, the proportion was 75%. The distribution of distances from a nest site to edge of the respective old-growth patch did not differ from random in either area (goodness-of-fit χ^2 $P>0.36$, $P>0.55$).

Univariate analyses on 5 sets of random points repeatedly identified shorter distances to the nearest fuzzy-edge clearcut, stream, glacier, and subalpine area as significant predictors of a murrelet nest location. A multivariate model selected only the distance to the nearest stream and subalpine area edge as significant predictors, supporting the emerging notion that Marbled Murrelets breeding in British Columbia may chose higher elevation, fragmented habitats with numerous available flyways.

PUBLISHED PROCEEDINGS OF SYMPOSIA OF THE PACIFIC SEABIRD GROUP

The Pacific Seabird Group holds occasional symposia at its annual meetings. Published symposia are listed below. They are available for purchase (unless out of print). To order, see the membership application/publication order form.

SHOREBIRDS IN MARINE ENVIRONMENTS. Frank A. Pitelka (Editor). Proceedings of an International Symposium of the Pacific Seabird Group. Asilomar, California, January 1977. Published June 1979 in Studies in Avian Biology, Number 2. Out of print.

TROPICAL SEABIRD BIOLOGY. Ralph W. Schreiber (Editor). Proceedings of an International Symposium of the Pacific Seabird Group, Honolulu, Hawaii, December 1982. Published February 1984 in Studies in Avian Biology, Number 8. Out of print.

MARINE BIRDS: THEIR FEEDING ECOLOGY AND COMMERCIAL FISHERIES RELATIONSHIPS. David N. Nettleship, Gerald A. Sanger, and Paul F. Springer (Editors). Proceedings of an International Symposium of the Pacific Seabird Group, Seattle, Washington, January 1982. Published 1984 as Canadian Wildlife Service, Special Publication. Out of print.

THE USE OF NATURAL VS. MAN-MODIFIED WETLANDS BY SHOREBIRDS AND WATERBIRDS. R. Michael Erwin, Malcolm C. Coulter, and Howard L. Cogswell (Editors). Proceedings of an International Symposium at the first joint meeting of the Colonial Waterbird Society and the Pacific Seabird Group, San Francisco, California, December 1985. Colonial Waterbirds 9(2), 1986. $12.00 *from* Ornithological Societies of North America, PO Box 1897, Lawrence, Kansas 66044; phone (800) 627-0629.

ECOLOGY AND BEHAVIOR OF GULLS. Judith L. Hand, William E. Southern, and Kees Vermeer (Editors). Proceedings of an International Symposium of the Colonial Waterbird Society and the Pacific Seabird Group, San Francisco, California, December 1985. Published June 1987 in Studies in Avian Biology, Number 10. $18.50.

AUKS AT SEA. Spencer G. Sealy (Editor). Proceedings of an International Symposium of the Pacific Seabird Group, Pacific Grove, California, December 1987. Published December 1990 in Studies in Avian Biology, Number 14. $16.00.

STATUS AND CONSERVATION OF THE MARBLED MURRELET IN NORTH AMERICA. Harry C. Carter, and Michael L. Morrison (Editors). Proceedings of a Symposium of the Pacific Seabird Group, Pacific Grove, California, December 1987. Published October 1992 in Proceedings of the Western Foundation of Vertebrate Zoology, Volume 5, Number 1. $20.00.

THE STATUS, ECOLOGY, AND CONSERVATION OF MARINE BIRDS OF THE NORTH PACIFIC. Kees Vermeer, Kenneth T. Briggs, Ken H. Morgan, and Douglas Siegel-Causey (editors). Proceedings of a Symposium of the Pacific Seabird Group, Canadian Wildlife Service, and the British Columbia Ministry of Environment, Lands and Parks, Victoria, British Columbia, February 1990. Published 1993 as a Canadian Wildlife Service Special Publication, Catalog Number CW66-124-1993E. *Free of charge from*: Publications Division, Canadian Wildlife Service, Ottawa, Ontario, K1A OH3, Canada.

BIOLOGY OF MARBLED MURRELETS—INLAND AND AT SEA. S. Kim Nelson and Spencer G. Sealy (Editors). Proceedings of a Symposium of the Pacific Seabird Group, Seattle, Washington, February 1993. Published 1995 in Northwestern Naturalist, Volume 76, Number 1. $12.00.

BEHAVIOUR AND ECOLOGY OF THE SEA DUCKS. Ian Goudie, Margaret R. Peterseen and Gregory J. Robertson (editors) Proceedings of the Pacific Seabird Group Symposium, Victoria, British Columbia, 8-12 November 1995. A special publication compiled by the Canadian Wildlife Service for the Pacific Seabird Group. Published 1999 as Canadian Wildlife Service Occasional Paper number 100, catalog number CW69-1/100E. *Free of charge from*: Publications Division, Canadian Wildlife Service, Ottawa, Ontario, K1A OH3, Canada.

SEABIRD BYCATCH: TRENDS, ROADBLOCKS AND SOLUTIONS. Edward F. Melvin and Julia K. Parrish (editors). Proceedings of an International Symposium of the Pacific Seabird Group, Blaine, Washington, 26-27 February 1999. Published 2001 by University of Alaska Sea Grant, Fairbanks, Alaska. Publication no. AK-SG-01-01. $xx.xx *from* the publisher.

BIOLOGY, STATUS, AND CONSERVATION OF JAPANESE SEABIRDS. Nariko Oka (editor). Proceedings of an International Symposium of the Japanese Seabird Group and Pacific Seabird Group, Lihue, Hawaii, February 2001. Journal of the Yamashina Institute of Ornithology 33(2); Symposium (5 papers), pp 57-147, other papers pp. 148-213. In English with Japanese abstracts $75.00.

Information on presenting symposia: Pacific Seabird Group Symposia are initiated by any PSG member with interest in a particular topic. The goal is to present a collection of papers that explore and review this topic, usually at an annual meeting of the Pacific Seabird Group. In some cases the papers are then edited and published as a PSG Symposium. Anyone interested in organizing a symposium must first contact both the Coordinator of the Publications Committee and the Scientific Program Chair for an annual meeting. Guidelines will be provided on obtaining approval and on organizing, presenting, and publishing a PSG Symposium, including the responsibilities involved.

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