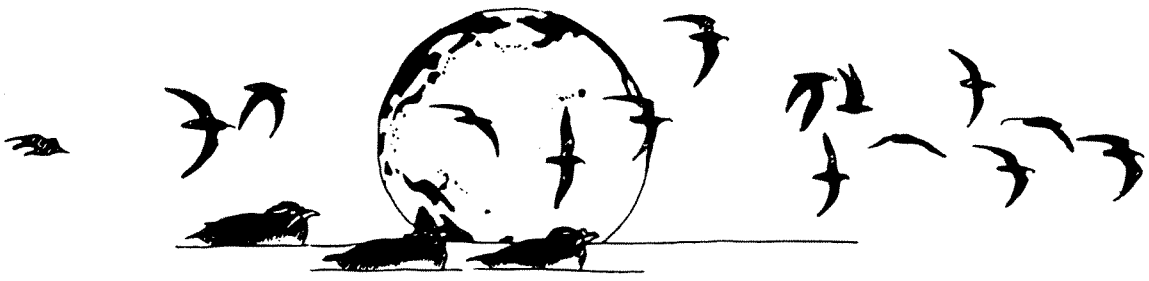
PACIFIC SEABIRDS



A Publication of the Pacific Seabird Group

Volume 30 Number 1 Spring 2003

PACIFIC SEABIRD GROUP

Dedicated to the Study and Conservation of Pacific Seabirds and Their Environment

The Pacific Seabird Group (PSG) was formed in 1972 due to the need for better communication among Pacific seabird researchers. PSG provides a forum for the research activities of its members, promotes the conservation of seabirds, and informs members and the public of issues relating to Pacific Ocean seabirds and their environment. PSG holds annual meetings at which scientific papers and symposia are presented. The group's publications include *Pacific Seabirds* (formerly the PSG Bulletin), *Marine Ornithology* (published jointly with the African Seabird Group and the Australasian Seabird Group), symposium volumes, and technical reports. Conservation concerns include seabird/fisheries interactions, monitoring of seabird populations, seabird restoration following oil spills, establishment of seabird sanctuaries, and endangered species. Policy statements are issued on conservation issues of critical importance. PSG members include scientists, conservation professionals, and members of the public from both sides of the Pacific Ocean. It is hoped that seabird enthusiasts in other parts of the world also will join and participate in PSG. PSG is a member of the International Union for Conservation of Nature (IUCN), the Ornithological Council, and. the American Bird Conservancy. Annual dues for membership are $25 (individual and family); $15 (student, undergraduate and graduate); and $750 (Life Membership, payable in five $150 installments). Dues are payable to the Treasurer; see Membership/Order Form next to inside back cover for details and application.

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Pacific Seabirds

Pacific Seabirds (ISSN 1089-6317) is published twice a year in the spring and fall. Pacific Seabirds informs PSG members about regional seabird research and conservation news. Pacific Seabirds seeks submissions of short peer-reviewed articles, reports, and other items that relate to the conservation of seabirds in the Pacific Ocean. Abstracts of papers presented at the annual meeting are included in the Spring issue; the Fall issue contains a summary of ongoing research. All materials should be submitted to the Editor, except that conservation-related material should be submitted to the Associate Editor for Conservation. Information for contributors to Pacific Seabirds is published in each Fall issue. Deadlines are March 15 for the Spring issue and September 15 for the Fall issue. Back issues of the Bulletin or Pacific Seabirds may be ordered from the treasurer; please remit $2.50 each for volumes1-8 (1974-1981) and $5.00 each for volume 9 and later (see Membership/Order Form next to inside back cover for details).

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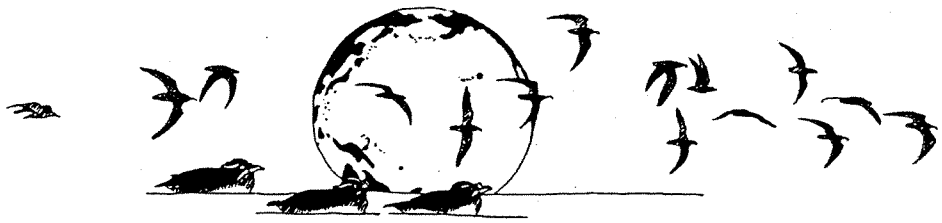
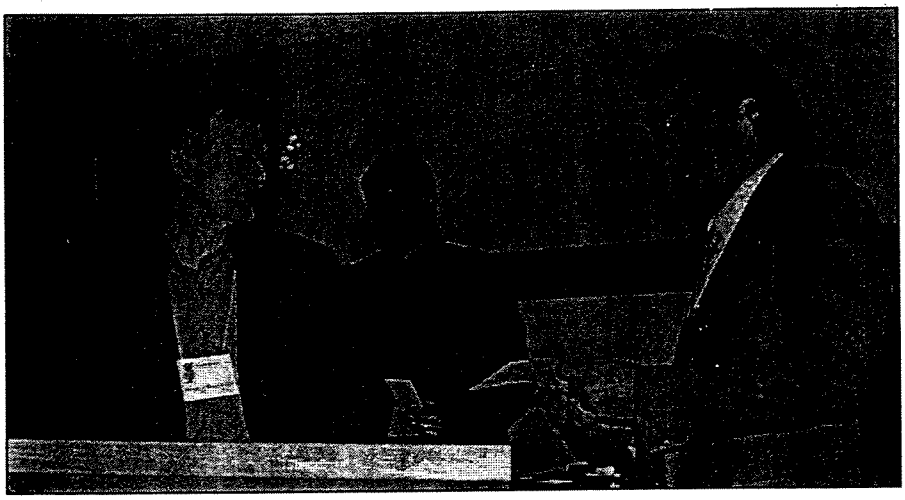


Dedicated to the Study and Conservation of Pacific Seabirds and Their Environment

Volume 30 2003 Number 1

LIFETIME ACHIEVEMENT AWARD

The Pacific Seabird Group occasionally honors outstanding contributors to seabird science and conservation with Lifetime Achievement or Special Achievement awards. PSG presented its Lifetime Achievement Award to Robert E. Ricklefs at its annual meeting on 22 February 2003.



Bob Ricklefs receives the Lifetime Achievement Award from David Irons and Dan Roby

ROBERT E. RICKLEFS

Daniel D. Roby

Dr. Robert E. Ricklefs received the Pacific Seabird Group's Lifetime Achievement Award in February 2003. Bob Ricklefs is an individual known to all seabird ecologists, even though most would not consider him a marine ornithologist per se.

The Pacific Seabird Group periodically presents awards to outstanding individuals who have made major contributions to the field of marine ornithology. One of these, instituted in 1993, is the Lifetime Achievement Award. This award recognizes a seabird researcher, educator, or conservationist who has made significant long-term contributions to seabird science, conservation, and education in the Pacific Ocean or the world. There is no mandate to present this award at every meeting, and in fact we have not done so. Rather the award is presented irregularly when a nomination for an individual who has made an outstanding contribution to marine ornithology is received and approved by the Executive Council. Past recipients of this award are Philip and Myrtle Ashmole, James Bartonek, William Bourne, Richard Brown, Charles Guiguet, Thomas Howell, James King, Karl Kenyon, Miklos Udvardy, and John Warham.

Bob Ricklefs' contributions are recognized and widely cited in the fields of evolutionary ecology, biogeography, phylogenetics, and community ecology. He has contributed important insights on the historical development of ecological communities and factors influencing patterns of species richness. Among his accomplishments, and most significant to our group of seabird aficionados, are his major contributions to our understanding of the ecology and evolution of life histories in birds. Bob has been publishing his scholarly works for nearly the last 40 years. Seabird biologists are fortunate that Bob has repeatedly turned his sharp perception towards the task of better understanding seabird life histories.

Bob received an AB in Biology from Stanford University in 1963 and a Ph.D. in Biology from the University of Pennsylvania in 1967. After a year as a postdoctoral fellow at the Smithsonian Tropical Research Institute in Panama, he joined the faculty of the University of Pennsylvania. He began producing a steady stream of now-classic papers the year he was awarded the Ph.D. degree, on topics that included growth rates, demography, and avian life histories. Among his most often-cited papers are those in *Ecology* on analyzing growth curves, in *Nature* on mortality rates in young birds, and a five-paper series in *Ibis* and *Auk* on patterns of growth in birds. The publication of his revolutionary and much-lauded textbook, *Ecology*, came within five years of his Ph.D. when he was only 30. That text is now in its

fourth edition (co-authored with G. Miller); his companion text, *The Economy of Nature*, recently came out in its fifth edition. With co-editor J.M. Starck, Bob produced *Avian Growth and Development: Evolution within the Altricial-Precocial Spectrum* a major treatment of the patterns of avian development. He also co-edited (with D. Schluter) the book *Species Diversity in Ecological Communities: Historical and Geographical Perspectives*. He now has over 250 scientific publications and book chapters to his credit, in addition to these and other books.

Bob's early and abiding interest in patterns of growth and demography in birds naturally led him to field studies of seabirds. He has worked on seabirds in such far-flung locations as the Caribbean, Bay of Fundy, Newfoundland, Hawaiian Islands, Christmas Island, Galapagos Islands, South Georgia, ant the Antarctic Peninsula. He has served as advisor for over a dozen Ph.D. students whose dissertations dealt mostly or entirely with seabirds. Among Bob's scientific publications are 43 specifically on seabirds. These began with papers on Sooty and Common Terns (*Sterna fuscata* and *S. hirundo*), Brown Noddies (*Anous stolidus*), and Leach's Storm-Petrels (*Oceanodroma leucorhoa*), and proceeded to cover such diverse taxa as Blue-footed Boobies (*Sula nebuoxii*), Northern Gannets (*Morus bassanus*), Adelie Penguins (*Pygoscelis adeliae*), Antarctic Prions, (*Pachyptila desolata*), Phoenix Petrels (*Pterodromqa alba*), Christmas Shearwaters (*Puffinus nativitatis*), Georgian Diving Petrels (*Pelecanoides georgicus*), Laughing Gulls (*Larus atricilla*), and Atlantic Puffins (*Fratercula arctica*). His paper on seabird reproductive energetics, published in *Studies in Avian Biology*, is a lucid discussion of energetic constraints in seabirds that has become a classic. Through experiments with Leach's Storm-Petrels, he has examined nestling growth rates, the factors limiting food delivery rates to nestlings, and the adaptive significance of pre-fledging fat accumulation and weight recession. This work has brought new insight to some of the more unique reproductive traits of pelagic seabirds.

In summary, Bob Ricklefs has made major contributions to the field of seabird biology and to our understanding of the ecological and energetic constraints on pelagic seabirds. He has made his contributions through his field research, laboratory studies, and modeling of seabird nutrition, growth, energetics, behavior, and life-histories. These studies have been expanded through the research of his graduate students. Moreover, his use of seabirds as models for exploring the evolution of avian life histories has conveyed a greater appreciation of these birds' unique biology to a wide scientific audience, including ecologists, physiologists, and evolutionary biologists. He richly deserves Pacific Seabird Group's Lifetime Achievement Award.

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CONSERVATION NEWS

This section contains current news on the management and protection of seabirds. Reports on recent research are also in Abstracts, including several about seabird-salmon issues on the Columbia River.

ANACAPA RAT ERADICATION AIDS XANTUS'S MURRELETS

According to the U.S. National Park Service, Xantus's Murrelets (*Synthliboramphus hypoleucus*) are responding to the eradication of some 3000 black rats (*Rattus rattus*) from Anacapa's three islets, which was completed last fall. Researchers found the first Xantus's nest since 1927 on Cat Rock (just off Anacapa), and the first nest on the uplands of Anacapa since 1929. Eggs in both nests have hatched. Radar studies are showing greatly increased nesting activity by Xantus's at Anacapa as compared to the past three years. Ashy Storm-Petrels (*Oceanodroma homochroa*) and Cassin's Auklets (*Ptychoramphus aleuticus*) have also benefited, as have Channel Island endemics such as deer mice (*Peromyscus* sp.), lizards, and salamanders, all of which were rat prey.

The National Park Service, U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game, National Oceanic and Atmospheric Administration (NOAA), and Island Conservation and Ecology Group removed the rats on Anacapa by a two-year project to drop poison-laced food pellets. The $1.6 million in project funds came from the 1990 *American Trader* oil spill off the coast of Huntington Beach, California. Animal rights groups protested the project, and the New York-based Fund for Animals sued the National Park Service in 2001 in an attempt to halt it. PSG and other organizations provided support to the U.S. Department of Justice to defend against the suit, and the federal judge allowed the project to proceed (*Pacific Seabirds* 29:97-98, 2002). The Fund for Animals still objects to the project, pointing out that 94 birds—mostly juvenile White-crowned Sparrows (*Zonotrichia leucophrys*)—were found dead on the island after the poisoning.

Researchers have found 17 Xantus's Murrelet nests on the island and in sea caves—the highest number ever recorded. Nest numbers are up 50% from the previous highest number during the most recent three years. Biologists have not found a single rat-eaten murrelet egg. Before the eradication, about 60% of the murrelet eggs that were found had been destroyed and showed signs of black rats' teeth. Ironically, researchers discovered the first documented nest on Anacapa of a Cassin's Auklet on Rat Rock, West Anacapa.

PSG SUPPORT FOR NEW ZEALAND SHEARWATER RESTORATION PROJECT

Using a unique international approach for oil spill resource recovery, PSG has provided written support for the Rakiura Titi Restoration Project, which seeks funds from the *Command* Oil Spill Trust Fund to eradicate introduced rats from four nesting islands in the Big South Cape Group, New Zealand. The *T/V Command* oil spill took place in late September 1998 in Monterey Bay, California. Shearwaters were the second most frequent species recovered in beached bird surveys subsequent to the spill and the most numerous species identified in aerial surveys. Among the recovered dead seabirds was a Sooty Shearwater (*Puffinus griseus*) that had been banded in New Zealand. Sooty Shearwaters are abundant in Monterey Bay during autumn as they feed and prepare to migrate south to New Zealand and Chilean breeding colonies. The rat eradication project will take place on a traditional Maori "mutton-birding" island, and, if successful, will allow for more muttonbirds to be harvested. PSG believes that it is appropriate to restore populations that have been damaged in oil spills at their colonies when this is the most efficacious means of restoration. Several years ago, PSG supported the proposal and ultimate decision of the *American Trader* Oil Spill Trustee Council in Southern California to restore a Brown Pelican (*Pelecanus occidentalis*) colony in Baja, Mexico (*Pacific Seabirds* 27:65, 2000).

PSG COMMENTS ON BRITISH COLUMBIA FOREST PLAN

Thanks to Anne Harfenist, Louise Blight and Alan Burger, PSG commented to British Columbia's Ministry of Sustainable Resource Management on the plan, "A Working Forest for British Columbia." PSG noted concerns and uncertainty over the effects of impending legislation on prospects for maintaining old-growth habitat for nesting Marbled Murrelets (*Brachyramphus marmoratus*), which are red-listed in British Columbia and "threatened" federally. The Canadian Marbled Murrelet Recovery Team and various provincial government agencies are currently at an early stage in meeting the requirements of the Committee on the Status of Endangered Wildlife in Canada and the federal Species at Risk Act for down-listing this species. PSG pointed out that any

restrictions on management options for old-growth forests will decrease the likelihood that the habitat needed for protection and recovery of the Marbled Murrelet will be attained. PSG recommended that Marbled Murrelet conservation issues in the forests of British Columbia be addressed by accepting the recommendations in the recent Special Report of the Forest Practices Board and in the Marbled Murrelet Recovery Team's comprehensive Conservation Assessment document.

RENEWED DEFENSE DEPARTMENT EFFORT FOR ENVIRONMENTAL LAW EXEMPTIONS

Last year, the Defense Department sought to be exempted from compliance with six environmental laws in the Fiscal Year 2003 defense authorization bill. Congress ended up approving a proposal that exempts certain training activities from the Migratory Bird Treaty Act, and another proposal that provides for the creation of undeveloped buffer zones surrounding military bases. Proposed exemptions from five other laws, including the Endangered Species Act, were not approved. The military is exempt only from incidentally taking birds in the course of other activities; it must still obtain permits if personnel plan to kill birds intentionally, for instance at airports for safety reasons. (The Department of Defense is not completely exempt from the Migratory Bird Treaty Act, as we inadvertently stated in *Pacific Seabirds* 29:97, 2002.)

Similar proposals are now pending before Congress in the defense authorization proposal for Fiscal Year 2004. Officials of the Department of Defense and Environmental Protection Agency say that the proposed exemptions will improve the military's ability to defend the nation, while still protecting endangered species and the environment. The Endangered Species Act proposal would exempt military bases and testing facilities from protection of critical habitat or species that have been designated under the act. Instead, military officials would continue the practice of submitting integrated natural resource management plans to the Interior Department for approval. They assert that private development and suburban sprawl has placed unfair burdens on the military. (In many developed areas, open lands owned by the Defense Department are the only available habitats for endangered species.)

Some environmental groups have voiced concerns that the Pentagon is using military readiness as an excuse to seek exemptions from environmental laws. Critics of such exemptions say environmental statutes already contain provisions that allow for exemptions in cases of national security or time of war. The Department of Defense counters that without legislative changes, lawsuits from environmental organizations can undermine military readiness (see *Pacific Seabirds* 29:10, 2002).

U.S. SUSPENDS DESIGNATIONS OF CRITICAL HABITAT

In May 2003, USFWS temporarily stopped designating tracts of land as critical habitat under the Endangered Species Act because the program has depleted its money for this Fiscal Year. The agency is negotiating with plaintiffs and federal courts to postpone deadlines for designating critical habitats. Critical habitat is defined as a geographic area that "contain[s] habitat features essential for the conservation of a threatened or endangered species," and the agency is required under the Endangered Species Act to identify such areas, where activities that may threaten those species can be curbed.

USFWS says it is caught between federal statutes and court decisions. Federal statutes forbid agencies to spend more money than Congress has appropriated, but USFWS also must comply with court-imposed deadlines. Environmental groups have brought a growing number of lawsuits seeking to force USFWS to designate critical habitat, as required under the law. While the program's $6 million budget is the same as last year's, the number of court-imposed deadlines has grown, leaving the agency about $2 million short of the money it needs to designate critical habitats for 33 species by 30 September 30 2003.

This issue is not new (*Pacific Seabirds* 28:11-12, 2001). Several years ago Interior Secretary Bruce Babbitt asked Congress to impose budget restrictions on the critical habitat program to prevent it from cannibalizing all funding for the Endangered Species Act, saying this was not the best use of those resources. Court-mandated critical habitat analyses were time-consuming, and they were draining resources and scientists from other protection for endangered species. The agency has been castigated for taking too long to list endangered species as well as to designate critical habitat. The log-jam will not be alleviated until the agency gets adequate funding as well as orders from the courts.

The administration has taken an unfavorable view of critical habitat. USFWS has begun inserting a "disclaimer" into critical habitat designations and news releases. It opens with the statement, "Designation of critical habitat provides little additional protection to species." The previous director of the USFWS, Jamie Rappaport Clark, decried the funds being spent on designation of critical habitat at that time; however, now that she is employed by an environmental group she takes the opposite position on this issue.

OFFSHORE WIND TURBINES AND SEABIRDS

A proposed wind turbine project in Nantucket Sound, off Cape Cod, Massachusetts, would consist of 130 towers topped with immense windmills and would produce a total of 420 mW. Cape

Wind Associates would be the developer. This proposal has garnered a great deal of attention because it might interfere with the pleasant coastal views at summer homes of wealthy and powerful political families such as the Kennedys. More important to PSG members, some offshore projects have a potential to kill seabirds.

Many other wind farms are under consideration along the Atlantic Coast. Winergy has undertaken an ambitious plan to identify 25 potential wind farm locations along the east coast including sites off of Massachusetts, New York, New Jersey, Delaware, Maryland and Virginia that could generate 12,500 mW of electricity. Some proposed wind farms are over 1000 mW, including a 506-turbine, 1821-mW proposal for Gulf Bank off the coast of Maryland. Offshore wind farms would be a new step for wind energy in the United States In 1981 there were only 10 mW of wind energy capacity in the nation; that capacity rose to 2554 mW in the year 2000 and nearly doubled to 4261 mW by the end of 2001.

Federal agencies are involved in jurisdictional battles on these issues. Because the coastal turbines would be built in the navigable waters of the United States, the U.S. Army Corps of Engineers has jurisdiction to issue permits just as with any other project affecting wetlands or navigation. Interior Department officials want Interior to permit, regulate, and collect royalty fees for operation of offshore wind farms. Interior notes that the current regulatory framework for those projects does not force developers to make any kind of payment for use of the federal submerged lands. In what might be viewed as a naked grab for power, they argue that Interior's Minerals Management Service deserves the job of regulating offshore energy development because it has decades of experience managing oil and gas production in federally controlled offshore areas. One Minerals Management Service official told Congress that it has unparalleled experience in multiple-use land management and routinely makes decisions to balance economic activities with the need to protect the environment. Concerns have surfaced over the potential threat to seabirds from offshore projects, just as there are concerns about terrestrial migratory birds from turbine projects on high ridges. Conservation groups are arguing that very careful consideration must be given to the potential for bird interactions at each site to prevent high avian mortality. From experience with communication towers, lighting on wind turbine towers must be limited to prevent birds becoming disoriented during poor visibility at night. The American Bird Conservancy suggests that only a few wind turbines in each project should be individually lit, and those towers should have a white strobe with a pulse rate of no more than 20 per minute.

The National Wind Coordinating Committee estimates that about 2 birds die per year at each turbine throughout the 15,000 wind turbines operating in 2001. The offshore turbines seem to be 3-4 mW each. A 1000-mW wind farm might consist of about 300 turbines, so the mortality rate of birds there could be extrapolated to somewhere around 600 birds per year. More study is needed to assess the actual impacts that might affect seabirds.

DELAWARE AND NEW JERSEY PROTECT HORSESHOE CRABS DURING SHOREBIRD MIGRATION

Delaware and New Jersey officials banned harvesting of the horseshoe crab (*Limulus polyphemus)* in Delaware Bay between May 1 and June 7, 2003. All spawning beaches will be closed to harvest during the critical period for spawning crabs and feeding shorebirds. Crabs are used as bait in conch and eel pots, including all taken in New Jersey and most taken in Delaware. This activity disturbs shorebirds and makes fewer crab eggs available to them for feeding.

Delaware and New Jersey also capped their harvest of crabs at one half of 2002 levels. They will require all conch potters to use bait-saving devices such as bait bags, which can reduce crab use by half. Restrictions will also be imposed on access to state and federal beaches during the peak spawning period. Delaware and New Jersey will seek funding to stabilize and enhance horseshoe crab spawning beaches and to conduct outreach programs to educate the public about disturbing the crabs and birds.

There are concerns about declines in Red Knot (*Calidris canutus*) and other shorebird populations linked to decreased crab egg availability. About 90% of the world's nearctic Red Knot (*Calidris canutus rufa*) population migrates from Tierra del Fuego to the high Arctic each spring, making a crucial stopover to feed on horseshoe crab eggs in Delaware Bay. Recent crab declines have meant that many of these shorebirds are not gaining sufficient weight to complete their migration and breed successfully. Dunlins (*Calidris alpina*), Semipalmated Sandpipers (*Calidris pusilla*), Ruddy Turnstones (*Arenaria interpres*), and Sanderlings (*Calidris alba*) are also highly dependent on crab eggs. Gerald Winegrad, Vice President for Government Relations, American Bird Conservancy, deserves much credit for persuading the state officials to take these actions.

SHIPS DUMP SLUDGE AT SEA, THEN FALSIFY RECORDS

A crackdown on ship pollution in the Northwest has uncovered evidence that tons of toxic oily sludge are dumped into the Pacific each year, then covered up with falsified records. In the past year, a captain and six chief engineers have gone to prison for installing hoses to bypass pollution control systems by pumping engine room wastes overboard. These cases involved up to 20 ships and generated millions of dollars in fines. At issue is how cargo and container ships handle leaking waste oil, solvents, and lubricants that accumulate in the engine room. Typi-

cally, water and oil are separated and the oil is stored as sludge in a tank. Some ships burn the sludge in on-board incinerators. Others store it until the ship docks, then offload it for disposal. But getting rid of sludge properly can be expensive and time-consuming.

The shippers covered up the illegal dumping by ordering crew members to hide evidence, obtain fake waste-disposal receipts, and paint over brackets that were used to bypass pollution controls. David Uhlmann in the Justice Department's Environmental Crimes Division believes the problem is so serious that his agency has ramped up enforcement, prosecuting cases on both coasts. The Puget Sound Steamship Operators Association, which represents cargo vessel operators, disputes that many vessels cut corners on environmental issues.

ARMY COMPLETES JOHNSTON ATOLL CHEMICAL WARFAREWASTE CLEANUP

Johnston Atoll, a key Pacific seabird-nesting site 800 miles southwest of Hawaii, once served as storage facility for rockets, bombs, artillery shells, and mines that were filled with a nerve agent so powerful that a drop on the skin can kill a person. During nearly a decade ending in November 2000, the Army destroyed more than 400,000 chemical munitions and 2000 tons of chemical agents on Johnston. The Army recently announced that it has incinerated all secondary waste from the massive disposal of chemical weapons. This includes plastic, paper, sludge, and other materials left over from destruction of some of the most dangerous chemical weapons ever produced. The material was packed into drums and thermally treated in the metal parts furnace on Johnston Atoll.

The military facility and airport runway are expected to be closed, and by 2004 the island will be returned to its more natural role as a refuge for seabirds and other creatures. The atoll and its remaining structures will be turned over to USFWS as part of the Johnston Atoll National Wildlife Refuge, which was established by Congress in 1926, long before the island became home to the deadly arsenal. A plutonium spill and contaminated soil will be part of the military legacy.

BOMBING STOPS ON VIEQUES ISLAND, PUERTO RICO

Sending fireworks shooting into the sky, Vieques islanders celebrated the U.S. Navy's withdrawal from their Caribbean island. Their protest movement helped force an end to nearly 60 years of bombing exercises on the island. President Bush announced in 2001 that the Navy would stop using Vieques this year. In the 1940s, the United States bought up 25,000 acres—about two thirds of Vieques—to create a bombing range, forcing out families and farmers. Military exercises began in 1947. The eastern third of Vieques will be administered by the USFWS forming the largest federal wildlife refuge in Puerto Rico, along with 3100 acres from a munitions warehouse on Vieques' western end. Many species of seabirds nest in the refuge.

VAST "NO FISHING" ZONES PROMOTED

More than 100 marine biologists issued a blueprint that seeks to reverse the decline of the planet's oceans. The group, convened by Intel co-founder Gordon Moore and Oakland marine biologist Sylvia Earle, recommended creating vast new "no fishing" zones at sea, and investing money to improve our catalog of marine species. While roughly 9% of the Earth's land is protected in reserves and parks, less than one percent of the ocean has similar protections.

The group also called on the nations of the world to draft new treaties and agreements to manage the 60% of the world's oceans that fall in international waters—areas largely open now to uncontrolled activities. The recommendations came after a scientific conference at Los Cabos, Mexico. Recently a study published in *Nature* concluded that 90% of the world's large predatory-fish populations, including tuna, swordfish and marlin, have disappeared because of overfishing in the past 50 years.

RATS ON KISKA THREATEN HUGE AUKLET COLONY

In July, the *Anchorage Daily News* ran a long article featuring the efforts by PSG member Ian Jones to document the destruction of auklets by Norway rats (*Rattus norvegicus*) on Kiska Island in the Aleutians. The colony at Sirius Point on Kiska has 3 to 6 million Least and Crested Auklets (*Aethia pusilla* and *A. cristatella*), which nest in a maze of tunnels, crevices, and cracks in the lava. Jones and his co-workers found windrows of bird skulls, rat dens jammed with rotting auklet carcasses, and many empty bird-nesting crannies in the jumbled lava. Not only do rats eat adults and chicks, they cache adult birds in underground burrows, where they can rot away uneaten. Jones found one cache with 148 decomposed birds. In 2002, Least Auklets had only 10% nesting success—the lowest ever observed for this species. Jones has concluded on the basis of modeling that the Least Auklet population could be extirpated if this rate of predation continues.

Like most other Aleutian islands, Kiska had no indigenous land mammals. Fox farmers released arctic foxes (*Alopex lagopus*) there in 1835, and Norway rats arrived with the Japanese occupation in World War II. In 1986, USFWS eradicated some 700 foxes on Kiska to protect Aleutian Canada geese and seabirds. The Norway rat population exploded with the foxes gone, although biologists do not think removing foxes helped the rats.

Alaska Maritime National Wildlife Refuge biologists Vernon Byrd and Art Sowls would like to eliminate the rats using Ramik Green, a government-approved poison. Kiska (70,000 acres) would be the largest island where that has been tried. In 2001, 200,000 rats were killed over 10 days on 27,900-acre Campbell Island, south of New Zealand. This effort cost $1.5 million for helicopters to spread 132 tons of bait. An experiment to poison rats at Sirius Point during winter is being developed. If the effort is successful, the refuge will try to get permission to spread bait from aircraft to eradicate rats from the entire island. Kiska may be only the beginning—rats have made it to at least 21 large Alaska islands, not counting their offshore islets.

In August 2003, PSG wrote to USFWS to urge that rats be removed from Kiska. USFWS was requested to provide sufficient funding and support to begin rat control at Sirius Point in 2004 and to eradicate the rats entirely from Kiska Island within a few years. PSG also offered to encourage support for the project among bird conservationists and the public during the governmental approval process. The Environmental Protection Agency needs to approve aerial application of rodenticides, among other hurdles. Letters went to both the Assistant Director for Migratory Birds and State Programs in Washington, D.C. (Paul Schmidt) and the Director of Region 7 in Anchorage, Alaska (Rowan Gould).

NOAA FISHERIES DEFERS MONITORING OF KODIAK BYCATCH

Monitoring of seabird and marine mammal bycatch in set-gillnets on the coast of Kodiak Island, Alaska began in 2002 (*Pacific Seabirds* 28[2]: 93-94). The project was a joint effort of two agencies, with USFWS providing expertise in bird identification and NOAA Fisheries (formerly the National Marine Fisheries Service) providing logistics and most of the observers. The project was expected to last two years at Kodiak and then move to other areas with intensive set-gillnet fisheries.

The expected Kodiak bycatch monitoring did not take place in 2003, however. According to Bridget Mansfield of NOAA Fisheries in Juneau, the postponement was due to lack of funds. Mansfield said that her agency intends to resume the Kodiak project in 2004, again in cooperation with USFWS. Monitoring of seabird bycatch in Alaskan fisheries has always been an interagency effort, owing to the complexity and expense of sampling large numbers of vessels adequately over large distances.

Descriptions of federal multi-year projects usually come with the caveat, "Depending on available funds, which are not guaranteed ." It is to be hoped that the agencies will give this important work a high priority in the future. It is unlikely that coastal gillnetting is affecting Alaskan colonies as severely as those in Japan (see next item); however, monitoring of bycatch is the only way to ensure this.

SYMPOSIUM HIGHLIGHTS JAPANESE SEABIRD CONSERVATION

The government of Japan, the Hokkaido Seabird Center, and USFWS sponsored a symposium on seabird conservation in Haboro, Hokkaido, Japan, in October 2002. The symposium was one outcome of a meeting that was held under the United States-Japan Migratory Bird Treaty in 2001. PSG members Kent Wohl and Kim Nelson were among several who attended from the United States.

One focus of the conference was the nearby island of Teuri. Although Teuri is a wildlife reserve, its seabird numbers have plummeted during the past century. This apparently has happened for two reasons. Coastal fisheries take many seabirds incidentally, without any impediment under Japanese law. And several hundred feral cats live on the island—but their removal is opposed by island's human residents.

The symposium was reported in *The Japan Times* on 31 October 2002. The paper pointed out that although murres on Teuri have become a sort of totem for local people, having "made their way onto posters, stained glass, and even steel drain covers," the birds themselves "have quietly slipped away." Common Murres (*Uria aalge*) have declined from 40,000 in the early 20th century to 8000 in the 1960s, a few hundred in the 1980s, and only 13 in 2002. Other Hokkaido seabirds have suffered similar declines, including Red-faced Cormorant (*Phalacrocorax urile*), Tufted Puffin (*Fratercula cirrhata*), Ancient Murrelet (*Synthliboramphus antiquus*), and Spectacled Guillemot (*Cepphus carbo*). Black-tailed Gulls (*Larus crassirostris*) still number in the thousands but also are declining.

The Japan Seabird Group placed 40 decoys at the murre colony in 2003. Koji Ono reports that the numbers of murre pairs increased to 19 in 2003; however, the area with the decoys was not used by birds. Meanwhile, threats from fisheries and cats continue.

A symposium report is being prepared. For more information, contact Kent Wohl, US Coordinator for the US-Japan Migratory Bird Treaty, U.S; Kent_Wohl@fws.gov

MIDWAY ATOLL MANAGEMENT CONTINUES, BUT NOT TOURISM

Midway Atoll belonged to the U.S. Navy for most of the 20th century, but when the base was closed it became a wildlife refuge. USFWS has been managing Midway to protect the islands' seabird populations, seals, and marine turtles, and to reverse decades of environmental neglect (especially by controlling invasive plants). Starting in 1996, tourists were able to visit the refuge and

enjoy its wildlife, historic sites, and beaches, and learn about seabirds and their environment. However, the contractor who managed the tourist services pulled out for financial reasons in early 2002. This put an end to public access; worse it threatened management of Midway's resources, since it would be impractical to maintain even a minimum permanent staff on the islands unless a contractor was maintaining the buildings, utilities, fuel farm, and airport (*Pacific Seabirds* 28:2-8, 2001, and 29:10-11, 2002).

USFWS has been able to contract for basic services in the past year and a half. However, it has not been possible to resume the provision of tourist facilities (dormitories, meals, a refuge ranger, and so on). According to Beth Flint of USFWS, public access would be feasible only if other agencies with an active interest in the islands were to contribute to funding of the maintenance contract. These agencies include NOAA (which manages the refuge's seals and marine turtles), the Federal Aviation Administration, Coast Guard, and Department of Defense (the latter three benefit from having an airport and fuel farm in the middle of the Pacific). The Department of Interior is again threatening to end all maintenance of island facilities if other agencies do not contribute. This would cripple wildlife management on Midway, even monitoring of declining albatross populations.

It is not new that federal funding is hard to come by, and this is especially true nowadays for nonmilitary projects. However, it is unfair to expect USFWS to carry the entire burden of maintaining facilities on which several agencies depend—and it is ironic that some of these facilities still contribute to the national defense.

PSG OPPOSES DEPREDATION ORDER FOR DOUBLE-CRESTED CORMORANTS

PSG joined a letter by numerous scientific organizations that opposed USFWS's proposed rule to establish a depredation order. The proposal would allow state and federal agencies in 24 states to decide when, where and how many Double-crested Cormorants they can kill if they determine the cormorants are "injurious to public resources." This proposal also would allow the U.S. Department of Agriculture to shoot unlimited numbers of cormorants at winter roost sites in twelve aquaculture states without permits or scientific review by USFWS.

Currently, a permit is needed from USFWS before cormorant control activities can occur, except at aquaculture facilities in thirteen states. Under this system, about 47,000 Double-crested Cormorants (*Phalacrocorax auritis*) are killed each year, in addition to the destruction of thousands of cormorant eggs. The permit system allows for a more orderly, science-based management approach than would the proposed rule. PSG and others noted that every study for a century has shown that cormorants do not have significant impact on the demography of desirable commercial or sport fish, except at very small scales. The major impetus for this proposal comes from perceived problems for sport fishing, but these are not supported by good science.

PSG COMMENTS ON SCOPING PROCESS FOR CASPIAN TERN ENVIRONMENTAL IMPACT STATEMENT

PSG commented to USFWS on the issues that should be addressed in the forthcoming environmental impact statement regarding Caspian Tern (*Sterna caspia*) management in the Columbia River estuary. PSG generally supported the three broad issues that USFWS had identified: (1) the impact of Caspian Terns on listed salmonids in the Columbia River estuary; (2) the need for active management of Caspian Terns; and (3) the need to address management actions that may be necessary to protect salmonid stocks in the Columbia River Estuary.

With regard to the impact of terns on salmonid recovery, PSG urged that USFWS use peer-reviewed science to make such an assessment. PSG noted that NOAA Fisheries produces many in-house reports on this subject that are not peer-reviewed and are not based on credible science; such reports are merely non-scientific justifications of its preconceived policy goals. PSG urged that these analyses distinguish between avian consumption of two distinct but intermingled groups of salmon: hatchery salmon, and wild salmon subpopulations (Evolutionarily Significant Units) that are listed under the Endangered Species Act. The scientific justification for listing Evolutionarily Significant Units under the act is that certain demes of salmon contain unique genetic information, use unique combinations of environmental and geomorphological conditions, occur over a unique geographic range, and represent a significant ecological component of the natural ecosystem. Hatchery populations of salmonids cannot meet these criteria, and they are not endangered under the Endangered Species Act.

PSG asked that the environmental impact statement specifically evaluate the option of including East Sand Island as a National Wildlife Refuge, and discuss how this action would contribute to the goals of the National Wildlife Refuge System as expressed in the National Wildlife Refuge Management Act. The U.S. Army Corps of Engineers (COE) currently owns East Sand Island and has expressed an intention to "excess" it (give up ownership of it). East Sand Island has the largest Caspian Tern colony on earth, the largest Double-crested Cormorant colony on the Pacific coast of North America, the largest night roost of California Brown Pelican (*P. o. californicus*) in the Pacific Northwest, and one of the largest colonies of Glaucous-winged/Western Gulls (*Larus glaucescens* X *L. occidentalis*) on the west coast.

PSG also suggested casting a broad net when discussing management options that may be necessary to protect salmonids in the Columbia River. Among these options should be the management of dams on the Columbia River, improved techniques at fish hatcheries, improvements in translocating salmonids, and modification of habitat.

CASPIAN TERN SITE FEASIBILITY STUDY

In February USFWS released a final version of its "Review of Caspian Tern Nesting Habitat: A Feasibility Assessment of Management Opportunities." This study was required as part of a settlement in a law suit brought by the American Bird Conservancy and other groups. USFWS evaluated 77 sites, 30 coastal and 47 interior. Twenty-three sites were determined to have management potential and were ranked according to specific criteria. Of these, six are in coastal Washington, four in Oregon, and thirteen in California. Of the six sites ranked with the highest management potential for Caspian Tern breeding, five are located in California, and one (Sand Island at Grays Harbor) is located in Washington. The state of Washington has refused to participate in any tern relocation efforts, and Oregon has agreed to review and consider sites only where Caspian Terns have historically nested. This left no new sites for active planning or development in Washington or Oregon except for three inland sites in Oregon (Malheur National Wildlife Refuge, Crump Lake, and Summer Lake). Five existing colonies in the San Francisco Bay area are being further evaluated for terns.

The political and public-relations hurdles to establishing any tern colony are significant. This is largely a result of mismanagement and public relations distortions by certain salmon advocacy groups and NOAA Fisheries. Many of the salmon smolts consumed by terns emanate from hatcheries; these smolts are not needed to restore Evolutionarily Significant Units (wild subpopulations listed under the Endangered Species Act), but rather are needed to maintain the fishery.

OWNERSHIP OF EAST SAND ISLAND, COLUMBIA RIVER, REMAINS UNSETTLED

As part of a settlement of a law suit with environmental organizations, USFWS and the U.S. Army Corps of Engineers (COE) agreed to issue a joint recommendation on future ownership of East Sand Island by March 1, 2003. The agencies also were supposed to make recommendations for funding to manage the island. The one-page statement that they issued failed to resolve either question and simply maintains the status quo.

The COE plans to dispose of the island and believes that transfer to USFWS is "the best end result to manage the significant wildlife resources present on East Sand Island." USFWS is shirking its responsibilities under the National Wildlife Refuge Management Act and says such a transfer decision is premature before the completion of an environmental impact statement. USFWS believes that other ownership options by state, municipal or conservation groups should be evaluated. The COE will retain ownership and management responsibilities of East Sand until the environmental impact statement is completed in February 2005, including provision of at least 6 acres of nesting habitat for Caspian Terns. If USFWS were to acquire the island, it would become part of the Oregon Islands National Wildlife Refuge.

WASHINGTON STATE TAKE OF CASPIAN TERNS AND OTHER SPECIES

In late February, the Wildlife Services agency of Washington State released a pre-decisional environmental assessment on Piscivorous Bird Damage Management on the Mid-Columbia River. This concerns Wildlife Services' control of Caspian Terns and other fish-eating birds at mid-Columbia River dams and hatcheries. Wildlife Services proposes to continue its avian predation control program in response to requests from public utility districts (PUDs) in Douglas, Chelan and Grant counties and at hatcheries.

From 1997 to 2001, Wildlife Services has taken 2380 Caspian Terns, 845 Great Blue Herons (*Ardea herodias*), 820 Black-crowned Night-Herons (*Nyctocorax nycticorax*), 1340 Common Mergansers (*Mergus merganser*), 36,835 Ring-billed Gulls (*Larus delawarensis*), 4285 Double-Crested Cormorants, and 11,120 California Gulls (*Larus californicus*). During 2001, 938 Caspian Terns (over 4% of the estimated breeding population on the west coast) were taken. After inquiries and letters of concern, Wildlife Services has apparently stopped taking Caspian Terns pending research by Julia Parish on tern predation at dam sites (*Pacific Seabirds* 29:12, 2002). The environmental assessment states that the lethal removal of Caspian Terns at PUD facilities will not occur unless conditions exist which attract unusually high numbers of terns. Should there be extreme low water and spill, "the limited taking of this species may occur, but only intermittently." As of early July, no Caspian Terns have been seen on the Columbia River north of the culling areas.

JUDGE FINDS PLAN TO PROTECT COLUMBIA RIVER SALMON TO BE INADEQUATE

In May, federal district court Judge James Redden ruled that a biological

opinion outlining salmon protection measures for the operation of Columbia River federal dams for five years is inadequate, and he remanded it to NOAA Fisheries for revision. The biological opinion was issued in December 2000 and outlines how the federal hydropower system on the Columbia and Snake rivers should be operated so as not to jeopardize 12 Evolutionarily Significant Units (subpopulations) of salmon and steelhead listed under the Endangered Species Act. Such biological opinions are required under the act when actions of federal agencies may impact a listed species. They are developed after consultations between the listing agency and the operational agencies. Specifically, this opinion addresses the operation of dams on the Columbia and Snake Rivers by the U.S. Army Corps of Engineers, the Bureau of Reclamation, and the Bonneville Power Administration.

The judge said the five-year biological opinion relied too heavily on future, speculative actions that might be taken to protect salmon and their habitat. Many of those future actions have not been subjected to consultation with the NOAA Fisheries and may never be implemented. For example, the plan relies on future land and habitat management actions by the Forest Service and the Bureau of Land Management that have not been subject to consultation.

Redden directed the NOAA Fisheries to consider only federal actions that have been subject to consultation and only those nonfederal actions that are "reasonably certain to occur." Environmental groups that initiated the suit had criticized the biological opinion for calling only for small changes in the operation of the hydropower system and relying instead on voluntary restoration actions by government agencies.

PSG NEWS

PSG ELECTS EXECUTIVE COUNCIL FOR 2003

The following members of the Executive Council were elected in fall 2001:

Officers:
Chair-elect: Dan Roby
Vice-chair for Conservation: Craig Harrison
Treasurer: Ron LeValley
Regional Representatives:
Southern California: Mark Pierson
Canada: Louise Blight
Oregon-Washington: Katie O'Reilly
Non-Pacific US: Malcolm Coulter

The complete list of Executive Council members is on the inside back cover. Roby, LeValley, Pierson, Blight, and O'Reilly were newly elected (Blight returns after a term as Student Representative). PSG welcomes them to the Executive Council. All except the Chair-elect will serve for two years; the Chair-elect will become Chair next year and Past Chair the year after.

Continuing members of the Exco include chair David Irons, past chair Lisa Ballance, secretary Lora Leschner, student representative Stephani Zador, and regional representatives: Alaska and Russia Verena Gill, Northern California Meredith Elliott, Pacific Rim Beth Flint, and Old World Mark Tasker.

EXECUTIVE COUNCIL CANDIDATES NEEDED

The following positions will be up for election in fall 2003:

Chair-elect
Secretary
Alaska representative
Old World representative
Pacific Rim representative
Northern California representative
Student representative

PSG needs more candidates for these positions. Pat Baird, chair (and only member) of the Election Committee), finds at least one candidate for each position each year. However, members are encouraged to nominate additional candidates, including themselves. Serving on the Executive Council is extremely interesting and keeps you up to date on conservation issues. It also is important—the Exco is what keeps PSG running.

CANADIANS AND BRITONS CAN PAY PSG DUES IN THEIR CURRENCY

As a convenience to PSG members who live in the United Kingdom and in Canada, the regional representatives in both countries can accept PSG dues in the local currency. Residents of the UK may send dues in pounds sterling to Mark Tasker; residents of Canada may remit payments in Canadian dollars to Louise Blight. Dues in US dollars should be converted to the local currency at the exchange rate for the date you are paying.

Residents of other countries will need to continue paying dues in US dollars. If you have questions, contact your regional representative or the PSG treasurer.

PSG'S 2004 MEETING WILL BE IN LA PAZ, BAJA CALIFORNIA SUR

The Pacific Seabird Group will hold its 31st Annual Meeting on 21–25 January 2004 in La Paz, Baja California Sur, México. Accommodation and meeting sessions will be at the Hotel Los Arcos in La Paz.

There will be a full scientific program on 22-24 January, and the meeting will feature a symposium, "The Brown Pelican in Western North America." Plenary speakers will include George Hunt, who will discuss "Climate change, bottom-up forcing, and its potential for affecting seabird populations," and Exequiel Ezcurra. Committees will meet on 21 January. Field trips on Sunday 25 January will include Espíritu Santo island, a cactus sanctuary, birdwatching, whale watching in Magdalena Bay, snorkeling with sea lions at Espíritu Santo Island, a Todos Santos Tour, and cultural and historitcal city tours of La Paz. For general information, contact the local committee chair, Eduardo Palacios in La Paz, at (612) 121 2800 or epalacio@cicese.mx. The scientific program chair is Dan Roby, (541) 737-1955 or daniel.roby@orst.edu. For meeting updates, check the PSG web page.

Hotel Los Arcos consists of three floors in a courtyard configuration. All rooms and suites are fully carpeted, air conditioned, and contain private baths, satellite television, direct access telephones, and mini-bars. The hotel has a fine restaurant, a coffee shop, and a bar lounge that features the city's best view of wonderful sunsets. Los Arcos is 10 minutes from the La Paz International Manuel Marquez de León Airport. You can contact the hotel for reservations at www.losarcos.com or (612) 122-2744; e-mail is preferred.

Transportation options to La Paz include air (from the southwestern US), ferry (from the Mexican mainland), or a rollicking bus trip from California. For flights from Los Angeles to La Paz, your choices are AeroCalifornia (800-237-6225) or AeroMexico (800-237- 6639; www.aeromexico.com). AeroMexico also flies from Phoenix or Tucson. Another option is to fly into San Jose del Cabo and take a three-hour bus ride to La Paz. Some of the airlines that service San José del Cabo airport are American (www.amrcorp.com) , Continental

(www.continental.com), American West (www.americanwest.com), Alaska (www.alaskaair.com) and Aero-California. AeroCalifornia is not on the web, so to get the best fares, we suggest calling them directly or check with your local travel agent.

Ground transportation is provided from the La Paz airport to town by Servicio de Transportación Terrestre. They offer a round trip between airport and city (including hotels) for US$25 per person. They also operate a round-trip shuttle for US$100 per person between the Los Cabos airport and hotels in La Paz. Or you can rent a car; rentals are conveniently located at La Paz International Airport and San Jose del Cabo airport — Thrifty (www.thrifty.com.mx), Dollar (lapdollar@hotmail.com), Hertz (www.hertz.com), Avis (www.avis.com), Budget (www.budget.com.mx), Nacional (reservations@grupoantyr.com.mx), Alamo (800 GO ALAMO [from within the US]; alamoreservas@prodigy.net.mx).

For those who are traveling from the Mexican mainland, there is a ferry service from Mazatlan and Topolobampo. Contact Sematur at 01 (612) 12 56588.

We look forward to seeing you at the 31st Annual Meeting in La Paz.

BUS TRIP TO LA PAZ

Dan Anderson (www.dwanderson@ucdavis.edu) is scheduling a bus trip from San Diego to the PSG meeting in La Paz. The trip will provide 5 days of birdwatching and sightseeing. Transportation costs will be shared by all members of the "expedition." Hotel reservations will be made ahead of time by Anderson; he will arrange the rooms *en masse* through La Pinta hotel system.

To save on space and costs, it will be necessary to share rooms, with at least two persons per room (with separate beds) or four per room (with shared beds). If you must have your own room, supposing they are available when our (hoped-for) crowd arrives, full cost will be your responsibility. There will be some opportunity for camping at some locations, but it will be cold at that time of year.

Bus transportation costs will be paid to Anderson directly. A deposit of $100 per person is required by early December 2003. Meals, motels, and all other personal expenses will be paid directly by each participant. Of course the bus will contain several ice chests of beer and soft drinks, and there will be snack food along the way. In fact, most everything except the bus fares and snacks will be each participant's responsibility.

The return trip will be by air; these reservations are your responsibility (see preceding article for details). It will be best to get airline reservations very early.

An approximate estimate of costs follows: Bus fare and incidentals:$200-300 per person; hotel room: $85 per night (*divided by* 1to 4 people sharing room); meals: $20 per day per person. Add some funds for incidentals.

FIRST-DRAFT ITINERARY FOR BUS TRIP (SUBJECT TO CHANGE!)

Day 1 (16 January)
- Meet bus Friday morning at San Diego airport
- Leave for Mexico at 1200 after lunch; travel to San Quintín, Baja California
- Chaparral, coastal sage scrub, northwest Baja Pacific Coast

Day 2 (17 January)
- Lunch at El Rosario, 1100
- Drive to Cataviña for night
- Baja California "Sonoran Desert" (recent biogeographers now classify the Baja Central Desert as a separate vegetation type from Sonoran Desert)

Day 3 (18 January)
- Lunch at Guerrero Negro about noon
- Drive to San Ignacio for night
- Central Desert, Vizcaino Desert, desert oasis

Day 3 (18 January)
- Lunch at Guerrero Negro about noon
- Drive to San Ignacio for night
- Central Desert, Vizcaino Desert, desert oasis

Day 4 (19 January)
- Lunch at Mulege about noon
- Drive to Loreto for night
- Magdalenan Region Desert, Sierra de la Giganta Region, Gulf of California

Day 5 (20 January)
- Leave Loreto about 0900
- Arrive La Paz about 1400
- From here you are on your own—stay at accommodations you have arranged for the meeting, prepare for meeting

End of meeting (25 or 26 January)
- One-way flight back to San Diego; resume round trip from San Diego to home. Arrange all flights on your own.

REPORT OF THE PACIFIC SEABIRD GROUP'S 30TH ANNUAL MEETING, FEBRUARY 2003

OVERVIEW

The 30th PSG Annual Meeting was held at the Tigh-Na-Mara Resort in Parksville, British Columbia on 19–22 February 2003. The beach was close at hand, and the weather was good for walks and birdwatching. About 230 people attended, of which more than 50 were students. One hundred and two lectures were presented and 45 posters were displayed. Authors from at least five countries came to present their work.

We were privileged to have three distinguished plenary speakers who gave excellent talks. The meeting was started

off by Dr. Robert Ricklefs speaking on "The extreme life histories of pelagic seabirds," followed by Dr. Helen James's talk on "Prehistoric human impacts on seabirds and their ecosystems," and finished up with Dr. David Cairns talking on "Endothermy, ectothermy, and the structure of marine communities."

There was a symposium on Seabird Biogeography, which contained several exciting papers; the proceedings will be published shortly in *Marine Ornithology*. In addition there were special sessions on the Impact of Offshore Wind Farms and Other Disturbances on Seabirds, Spatial and Temporal Overlap of Seabirds and Fisheries, and Related Seabird Bycatch Issues, and Seabird Monitoring Data as a Tool to Evaluate Ecosystem Processes and Initiate Conservation Actions. Topics of papers in the general sessions included breeding biology, effects of oil pollution and other contaminants on seabirds, habitat relationships, behavioral ecology and natural selection, conservation, management, general biology, and foraging ecology.

The Pacific Seabird Group presented Dr. Robert Ricklefs with a Lifetime Achievement Award in recognition of his outstanding and original contributions to evolution and ecology of seabird life histories (see tribute to Dr. Ricklefs elsewhere in this issue).

Field trips were offered to the Mount Arrowsmith Biosphere Reserve, Baynes Sound, Winchelsea/Ballenas Archipelago, and Carmanah Walbran Provincial Park. The weather cooperated nicely.

The local committee did an outstanding job, and many people commented how well-organized the meeting was. The committee chair was Doug Bertram; he was assisted by Shelagh Bucknell, Ron Ydenberg, Mark Hipfner and many others. [*Editor's note:* Among the things this committee deserves credit (?) for was the biggest-ever dessert buffet at the banquet; there was even an ice cream sculpture.]

Student Travel Awards

PSG was able to provide financial assistance to attend the meeting, thanks to generous contributions from the Canadian Wildlife Service and the U.S. Fish and Wildlife Service. Successful applicants included Sarah Davis, Adrian Gall, Who-Seung Lee, Matthew Logan, Heather Major, Rosana Paredes, M. Zachariah Peery, Samantha Richman, Brian Walker, Tammy Steeves, and Stephanie Zador

Student Awards for Papers and Posters

PSG has long recognized that our strength is in our young and innovative members, and we encourage all students to present their work at our annual meetings. Each year PSG presents awards for the best student paper and the best student poster. This year we are happy to announce that Rosana Paredes from Memorial University of Newfoundland won the best student paper award for her presentation on "Do time depth recorders affect chick provisioning behavior in Thick-billed Murres (*Uria lomvia*)?". Heather Wilson from Anchorage, Alaska won the student poster award for her work on "Concentrations of trace elements in blood of Spectacled and King Eiders in northern Alaska."

—David Irons

RESPONSE TO PARTICIPANT QUESTIONAIRE

For the second year, a questionnaire was prepared for attendees of the PSG annual meeting. Here are the responses for the 30th Annual Meeting in Parksville, BC.

Did you attend the 29th Annual Meeting in Santa Barbara?
Yes—32
No—14
Other—0

How many days did you attend the 30th Annual Meeting in Parksville, BC?
1 day— 0
2 days—0
3 days—7
4 days—22
5 days—12
6 days—4

Do you plan to attend the 31st Annual Meeting in Mexico?
Yes—38
No—2
Other—6

Do you think you received a reasonable value for your registration fee?
Yes—44
No—1
Other—1

If a secure web site were available, would you use it to pay registration fees by credit card?
Yes—37
No—6
Other—3

Did you find the abstract submission process via the web site useable?
Yes—25
No— 0
Other—21

Did you receive sufficient information via the web site without paper mailings?
Yes—35
No—10
Other—1

Did you attend a pre-conference committee meeting?
Yes—21
No—25
Other—0

Did you like having plenary speakers, and were there too many, too few, or just right?
Just right—35
Too many—9
Too few—1
Other—1

Was there sufficient space to view the posters?
Yes—29
No—6
Other—1

Did you like having a dedicated time to view posters?
Yes—45
No— 0
Other—1

Did you like having symposia, and were there too many, too few, or just right?
Just right—29
Too many—6
Too few—1
Other—10

Did you like having social events/mixers, and were there too many, too few, or just right?
Just right—37
Too many—1
Too few—4
Other—4

GENERAL COMMENTS

Many people liked the meeting and were happy with the location. The local committee was repeatedly complemented for the wonderful job they did in organizing and running the technical aspects of the meeting. High praise was given to the session chairs for keeping the speakers on time, which allowed the concurrent sessions to run smoothly. People liked having the cost of lunch paid as part of the registration fee because it allowed people to interact more and get back to the meetings on time. Several people noted that the rooms could have been a bit larger with higher ceilings—the screens would have been easier to see. People talking outside of the meeting rooms were disruptive to some.

There were several comments made by only one or two people. These included: lower-quality talks should be presented as posters; the detailed program should be on the website prior to the meeting, so people can find out when they are speaking; cost for using the hotel's business center was high; 10 minutes is too short for an oral presentation; the style of the printed program was good; the program needed more room on pages of abstracts for notes; T-shirts should be offered for sale; the lunchtime Conservation Committee meeting did not work well; and PSG needs to spend more money on conservation issues.

—David Irons

MINUTES OF 2003 EXCO MEETING

Pacific Seabirds routinely publishes a summary of the minutes for each year' PSG Executive Council meeting. This year the summary will appear in the fall issue.

PSG PLANS 2005 MEETING IN PORTLAND WITH WATERBIRD SOCIETY

The Pacific Seabird Group and the Waterbird Society will meet jointly in January 2005, in or near Portland, Oregon. Dates of the meeting are still to be determined, but will it probably take place between the 2nd and 4th week of January. Katie O'Reilly will organize the local committee. More information will be available by the time of the 2004 meeting.

CORRECTIONS

It was inadvertently stated in *Pacific Seabirds* 29:97 (2002) that the Department of Defense is completely exempt from the Migratory Bird Treaty Act. In fact, the military is exempt only from incidentally taking birds in the course of other activities; it remains subject to the Act and its permit requirements when its personnel intentionally kill birds (e.g., at airports for safety reasons).

In *Pacific Seabirds* 29(2), 2002, the footer on pages 81-91 erroneously said it was volume 28. Apologies to the authors. Other pages were correctly labeled.

If you notice an error in *Pacific Seabirds*, please let the editor know.

SEABIRD NEWS

GLOBALLY THREATENED BIRD UPDATE

BirdLife International is compiling a "Globally Threatened Bird Update." This will be fed into the 2004 revision of the Red List, to be issued by the International Union for the Conservation of Nature. On-line forums were held through August 2003 on topics of the greatest concern, including Pacific birds and seabirds in general. Topics ranged from whether to adjust a species' level of listing, to whether demographic data for a threatened species can be extrapolated from a related one that is abundant. Species that were discussed included Short-tailed, Black-footed, and Laysan Albatrosses (*Phoebastria albatrus*, *P. nigripes*, and *P. immutabilis*), Ashy Storm-Petrel (*Oceanodroma homochroa*), Black-vented, Sooty, and Newell's Shearwaters (*Puffinus opisthomela*, *P. griseus*, and *P. newelli*), Ivory Gull (*Pasgophila eburnea*), Red-legged Kittiwake (*Rissa brevirostris*), Xantus's Murrelet (*Synthliboramphus hypoleucus*), and Marbled, Kittlitz's, and Long-billed Murrelets (*Brachyramphus marmoratus*, *B. brevirostris*, and *B. perdix*).

Comments and draft documents can be viewed at http://www.birdlife.net. Search for "Globally threatened"; from there, you can download documents or select "Globally Threatened Bird Forms."

CONFERENCE EVALUATES METHODS FOR MONITORING AUKLETS

At the Alaska Seabird Working Group Meeting in March 2003, a symposium was held on the problems of monitoring auklet populations. Topics included the traditional methods of counting birds on the surface and mark-resighting; new ideas included indices based on lichen cover on rocks, infrared and remote sensing, area occupied by the colony, and sound levels at the colony. Recommendations on ancillary data to help analyze population changes included stress hormones, population genetics, and population modeling. A full report on the recommendations is planned for the next issue of *Pacific Seabirds*. For more information contact David Irons, U.S Fish and Wildlife Service, Anchorage, Alaska (David_Irons@fws.gov).

ALBATROSS FROM TERN ISLAND FOUND ON HOKKAIDO BEACH

The carcass of a five-year-old Laysan Albatross was recovered on a beach at Erimo, Hokkaido, Japan on 19 August 2003. The U.S. Fish and Wildlife Service reported that the bird was banded on 29 May 1997 at Tern Island, French Frigate Shoals, Hawaii. Laysans are known to travel throughout the western Pacific, but biologists appreciate every opportunity to document age-specific movements.

WEBSITE GIVES BIRD TAXONOMY AND DISTRIBUTION DATA

A new website called Avibase contains taxonomic and distribution information for 10,000 extant species and 22,000 subspecies of birds, plus some extinct species. The creator of the site, Denis Lepage, says that it contains close to a million records, including 300,000 occurrence records and 180,000 synonyms in over a dozen languages, and represents 12 years of work. The URL for the site is http://www.bsc-eoc.org/avibase/avibase.jsp

ABSTRACTS

ABSTRACTS OF PAPERS AND POSTERS PRESENTED AT THE 30th ANNUAL PACIFIC SEABIRD GROUP MEETING
Tigh-na-Mara, Parksville, British Columbia
19-22 FEBRUARY 2003

Oceanographic climate, euphausiids, and auklet nesting: effects of regime shifts on phenology, diet, and growth of a planktivorous seabird

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Ecosystem regime shifts transpired in the North Pacific Ocean in 1976-77, 1989–90, and most recently in 1998–99. Evidence suggests that zooplankton abundance and distribution varies significantly interannually and between regimes. In central California, Cassin's Auklets forage on the euphausiids *Thysanoessa spinifera* and *Euphausia pacifica*, and the abundance of these species is hypothesized to depend upon seasonal changes in the timing and intensity of upwelling, and the corresponding variance in sea temperature. In this paper, we investigate the ecological consequences of inter- and intradecadal variability in winter and spring oceanographic climate in the southern California Current System (CCS) by examining the timing of breeding, growth, diet composition, and parental provisioning of planktivorous Cassin's Auklets from 1973 through 2001.

Interannual quadratic trends were present in several mean monthly values of upwelling (UI; negative) and sea temperature (SST; positive) over time; significant effects of regime were also observed. The harvest of *T. spinifera and E. pacifica* by auklets showed significant opposite quadratic trends through time, but with no significant effects of regime. Diet sample mass decreased significantly through time, becoming lower with each regime. There was significant interannual variability in auklet growth rates, but we found no significant effect of regime on growth. We used a backward stepwise regression procedure to determine relationships between oceanographic conditions, diet and growth. The best model was one that incorporated the proportion of *T spinifera* in the diet and the difference between May and March SST (reflecting the strength of the spring transition).

There is some indication that euphausiids responded to changes in ocean climate as indexed by auklet diet composition and provisioning mass. Our results support the idea that both spring upwelling and sea temperature influence euphausiid availability, at least as measured by auklet diet composition and provisioning amounts. The overall decline in parental provisioning amount over time is consistent with the observation that zooplankton biomass in the CCS has declined by 80% in recent decades. Growth rate was related to spring sea temperature and this effect is likely mediated through variable euphausiid abundance. We plan further studies on the foraging effort or strategy of individual parents under variable oceanographic conditions, and how these individual contributions affect nestling growth and development.

Inland flight patterns of nesting and non-nesting Marbled Murrelets in redwood National and State parks during the 2001 and 2002 breeding season

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Marbled Murrelets (*Brachyramphus marmoratus*) were captured at sea and radio-tagged in April and May 2001 (n = 23) and 2002 (n = 44) near Redwood National and State Parks, California. Birds flying inland were followed from ocean to inland use sites using a combination of automated remote telemetry recording stations and mobile human-operated telemetry. In 2001, 5 murrelets initiated nests and 14 non-nesting (nesting not detected) murrelets flew inland routinely. In 2002, 21 murrelets initiated 19 nests and 16 non-nesting murrelets flew inland routinely. For murrelets that initiated nesting, data was stratified by the breeding stage (pre-nest, incubation, nestling, and post-fledging). For birds with adequate data, geographical flight paths and the timing of flights were similar for dawn flights across nesting and non-nesting murrelets. Evening flights differed between nesters and non-nesters. Inland flights of Marbled Murrelets after fledging or nest failure may have important behavioral or social considerations.

Food habits of chick-rearing Cassin's Auklets nesting on Prince Island and foraging in the Santa Barbara Channel, California during a prolonged La Niña event

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Landing, California 95093, USA; josh_adams@usgs.gov; [2]U. S. Geological Survey, Western Ecological Research Center, San Francisco Bay Estuary Field Station, P. O. Box 2012, Vallejo, CA 94592, USA; [3]Humboldt State University, Department of Wildlife, Arcata, CA 95521, USA

We investigated the prey delivered to nestling Cassin's Auklets *Ptychoramphus aleuticus* coincident with measured foraging areas of adults during three consecutive chick-rearing seasons (1999–2001) on Prince Island, California. Radiotelemetry demonstrated prolonged spatial and temporal consistency in adult foraging dispersion, with subtle intra- and interannual differences. While rearing chicks, auklets restricted foraging to within 45 km from their colony, and aggregated over insular shelf waters near the 200 m isobath, demarcating the southern rim of the Santa Barbara Basin. During late 2000 and throughout 2001, auklets ranged over deeper basin waters. In all years, adults provisioned nestlings, primarily with euphausiids (86% and 65% by number and mass respectively), age-0 fishes (8% N and 29% M), and minor amounts of cephalopods (< 1% N and 4% M). According to the Geometric Index of Importance (GII), *Thysanoëssa spinifera* juveniles and adults were the most important items (GII = 64.5 and 55.4, respectively), followed by *Euphausia pacifica* (GII = 37.3), pleuronectid fishes (GII = 37.1), *Nyctiphanes simplex* (GII = 17.5), cephalopods (*Loligo opalescens*, and *Octopus* spp.; GII = 16.1), and rockfish (*Sebastes* spp.; GII = 14.9). Overall, diet diversity was high (51 unique taxa) including 15 species of copepods and 5 species of hyperiid amphipods. *Thysanoëssa spiniferea* was most important during 1999 and 2001, whereas *E. pacifica* replaced *T. spinifera* in 2000 after an anomalous eastward inflection of the California Current occurred off Point Conception during Mar–April. During 1999 and 2000 auklets took adult *T. spinifera* during both halves of the season, but switched to juveniles presumably as adults terminated spawning and became unavailable in the upper water column. During 2001, adult *T. spinifera* were poorly represented compared with juveniles indicating reduced local spawning. Auklet nesting phenology varied among years; hatching was early and protracted in 1999 compared with 2000 and 2001. Breeding success, pre-fledging mass, and nestling mass gain were similar in all years despite large variation in prey species composition. Auklets nesting on Prince Island take advantage of seasonally persistent aggregations of local euphausiids, and larval–juvenile fishes, with dietary composition determined in part by fluctuations in upwelling, regional circulation, and prey life history patterns.

Fearing feathers: predation risk by avian predators affects behavior of Tufted Puffins

BriAnne A. Addison and *Ronald C. Ydenberg*. Centre for Wildlife Ecology, Simon Fraser University, Burnaby, British Columbia, V5A 1S6, Canada; baddisoa@sfu.ca

Tufted Puffins (*Fratercula cirrhata*) forage at sea and provision nestlings diurnally so are potentially subject to predation by avian predators such as peregrine falcons (*Falco peregrinus*) and bald eagles (*Haliaeetus leucocephalus*). Puffins face the most predation risk when they approach or depart from a slope at the colony, and are safest in their burrows or on the water where they can escape predators. Predation has direct effects on populations because predators are lethal, and also indirect effects on the behavior of individuals due to fear of predation. If Tufted Puffins perceive a predation risk by avian predators then they should engage in behavior that will reduce their risk level. In 2002 on Triangle Island, British Columbia, we monitored behavior of puffins arriving and departing from the colony and scored occurrence of behaviors, and presence/absence of raptors, with an event recording program. Risky behaviors included landing and departure from the slope. We predicted that behavior should be modified to reduce risk when raptors are present by either avoiding risky behaviors, or timing arrival/departure behavior to occur in groups to minimize risk to the individual. We found that risk of predation by raptors appears to have an impact on behavioral decisions made by Tufted Puffins; occurrence of risky behaviors was reduced when raptors were present, and individuals postponed slope departures so that they could move in a group when risk of predation was higher. Indirect effects of predation by avian predators on puffins have consequences for reproductive decisions.

Seabird band returns from Peruvian fisheries *[Poster]*

Joanna Alfaro-Shigueto[1] and *Jeffrey C. Mangel*[2] [1]Pro Delphinus, Octavio Bernal 572-5, Lima 11, Peru; jas_26@yahoo.com [1]Duke University Marine Laboratory, 135 Duke Marine Lab Rd., Beaufort, North Carolina 28516, USA

Peruvian fisheries were at one time the largest in the world. However, due to socioeconomic and cultural factors, ineffective regulations and deficiencies in law enforcement these fisheries have not been well managed. This is especially true with regard to the issue of bycatch. The bycatch of cetaceans has been documented in some fisheries. This provided information on mortality rates, distribution and occurrence of dolphins and whales off Peru. However, information on the interaction of fisheries with other protected species, such as sea turtles and seabirds, is still scarce.

During a project in 2002 to assess sea turtle mortality in fisheries we obtained bands from seabirds that occurred as bycatch in artisanal fisheries in Peru. Band returns were obtained from two locations along the Peruvian coast. First, in Mancora (04° 05' S, 81° 04' W) one band was recovered from an albatross that was caught by a local fisherman. Second, in Salaverry (08° 14' S, 78° 59' W) approximately 20 bands have been reported, mainly from the artisanal

longline shark fishery. These bands included two return addresses: (1) U.S. Fish and Wildlife Service and (2) The British Museum. At least one band reported from Salaverry was from a Waved Albatross *Diomedea irrorata*, banded in June 1994 in the Galapagos Islands.

Commercial and artisanal fisheries in Peru represent an as yet untapped source of band returns and are therefore a potential source of information regarding levels of seabird bycatch and areas of occurrence off the Peruvian coast.

Keep it simple—selection criteria of marine protected areas for seabirds

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Marine protected areas (MPA) comprise many forms, ranging from complete to limited restrictions on activities and scientists and resource managers are closely examining the criteria for MPA designation. In the Gulf of the Farallones, California, we identified several potential sites for marine protected area designation based on simple criteria including ecological, sociological and regulatory components. Ecological criteria included elements such as rarity and diversity of seabirds and other marine species, and source population significance. Sociological criteria took into account elements such as commercial and sport fishing effort. Regulatory criteria took into account jurisdiction, existing designations, and enforcement capabilities. We used a Geographical Information System (GIS) to analyze spatial relationships. For example, we mapped the distribution and abundance of common seabirds, the distribution of species diversity, the distribution of California Department of Fish and Game Block data and the spatial extent of jurisdictions. Applying GIS models, we identified MPAs using simple Boolean logic with the above criteria. Hot spots such as Point Reyes Headland, for example, ranked high for all criteria. Ecologically, the site is significant, exemplifying one of the few locations in the world where major coastal upwelling occurs, and having great diversity and abundance of marine species, including nesting and roosting seabirds. Fishing effort is limited because of remoteness and hazardous conditions. Finally, Point Reyes Headland comes under the jurisdiction of several agencies. These simple GIS models, using basic criteria, allow managers to promptly identify MPAs without extensive, long-term research to justify designation.

The diet of Arctic Tern chicks as a predictor of herring landings in the Grand Manan weir fishery *[Poster]*

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Information derived from seabirds is potentially useful to fisheries science. Seabird data as an estimate of prey availability are cheaper to obtain than traditional fisheries abundance indices. Seabirds interact with human fisheries by preying on the same prey species, by taking either the same or a younger age class. Consequently, correlations with commercial fisheries may be immediate or delayed depending on the age class of prey taken by seabirds. Arctic Terns (*Sterna paradisaea*) breeding on Machias Seal Island deliver age-0 herring (*Clupea harengus*) to their chicks; the youngest age class of herring taken by the commercial weir fishery of Grand Manan is age-2. If Arctic Terns can accurately predict the strength of recruitment of herring into the commercial fishery then the proportion of age-0 herring in the diet of Arctic Tern chicks in year x should be positively related to the commercial catch per unit effort (CPUE) of age-2 herring two years later. Information on diet was collected from terns in 1990–2000; herring weir CPUE (total and age-2) for Grand Manan was obtained for 1992–2002. Linear regression revealed a nonsignificant relationship between the proportion of herring and CPUE of age-2 herring, but a significant relationship between the proportion of herring and total CPUE.

Caspian Tern predation on juvenile salmonids in the mid-Columbia River

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We investigated Caspian Tern (*Sterna caspia*) predation on juvenile salmonids (*Oncorhynchus* spp.) in the mid-Columbia River in 2000 and 2001. We used a bioenergetics modeling approach to estimate total fish consumption by Caspian Terns nesting at Crescent Island, located near the confluence of the Snake and Columbia rivers. The predominant prey type in the diet of Crescent Island terns was juvenile salmonids, and we estimated that Caspian Terns breeding at Crescent Island consumed 465,000 juvenile salmonids (95% CI: 382,000–547,000) during the 2000 breeding season, and 679,000 juvenile salmonids (95% CI: 533,000–825,000) during the 2001 breeding season. Total salmonid predation by Crescent Island Caspian Terns was less than that reported for other predators in the Columbia River (i.e., Caspian Terns nesting in the Columbia River estuary and northern pike-minnow (*Ptychocheilus oregonensis*) in the John Day Reservoir, but more than that reported for gulls foraging at Wanapum dam. All of these predators have been, or are being, managed to reduce predation rates on juvenile salmonids. Consequently, the decision by state, federal, and tribal resource managers on whether to manage Caspian Terns nesting at Crescent Island will not be straightforward.

ABSTRACTS

Biogeography of foraging strategies among procellariiform seabirds: how productivity in surrounding waters influences foraging

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Procellariiform seabirds exhibit high levels of parental care while they continue to forage for distant food resources and maintain their own body condition. Recent evidence suggests that many Procellariiform taxa balance the costs of parental care and maintaining their own body condition by alternating the length of foraging trips during the chick-rearing period. Several taxa alternate short (coastal, 1–5 days) and long (pelagic, 7–20 days) foraging trips thereby exhibiting a bimodal foraging strategy. However, this strategy is not universal among the Procellariiformes. The dual foraging strategy is not consistently observed among different populations of the same species and can vary from year-to-year for a population in a particular region. This presentation will address the biogeography and variability in foraging strategy among taxa that conduct unimodal versus bimodal foraging trips, or both. Variability in foraging strategy (unimodal versus bimodal trips) will be related to average productivity (chlorophyll a) of waters surrounding colonies, variability in productivity, and type of habitat surrounding colony. Distribution and the amount of production in the foraging environment of Procellariiform seabirds may influence strategies made by parents about how to provide for young. We will explore whether unimodal feeding in a relatively predictable environment with nearby resources can be just as profitable as an alternating foraging effort between near and distant resources.

Variation in provisioning and fledging success of Red-throated Loons (*Gavia stellata*) in western Alaska: regime shift as a potential mechanism for long-term population decline *[Poster]*

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Numbers of Red-throated Loons (*Gavia stellata*) in Alaska markedly declined in the past quarter-century, due to unknown causes. The other three members of the Gaviidae family, all of which nest sympatrically with the Red-throated Loon in Alaska, have remained stable, suggesting the reason for the decline may lie in the Red-throated Loon's greater reliance on the marine environment. Rather than providing young with fish and invertebrates from the nest pond, as is the typical habit of other loons, Red-throated Loons collect fish for their young away from the nest pond primarily in the marine environment. In recent decades, large-scale changes have occurred in the physical properties of the North Pacific and Bering Sea and, subsequently, the associated marine community including some small forage fish species. The resulting impact has been a decline in a number of top predator populations resulting primarily from a reduction in productivity. These changes may have also had important consequences in terms of the quality and/or quantity of prey available to Red-throated Loons when raising young. We are investigating the relationship between provisioning variation and growth and survival of pre-fledglings to predict to what extent hypothesized changes in the fish prey community might have impacted reproductive success.

Contaminant residues in murre eggs from colonies in the Gulf of Alaska and Bering Sea

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Analyses of Common and Thick-billed (*Uria aalge* and *U. lomvia*) Murre eggs from colonies in the Gulf of Alaska and Bering Sea suggest substantial temporal, geographic, and species differences in residue levels of persistent organic contaminants and mercury. Recent results from St. George and Bogoslof island Common Murre colonies in the Bering Sea compared to mid-1970s data collected at these locations suggest that substantial declines have occurred in some compounds over the last 30 years, while little or no change has occurred in others. Also, eggs from Gulf of Alaska murre colonies tended to contain higher concentrations of persistent organochlorine compounds and mercury than those from the Bering Sea colonies. Principal components analyses (PCA) of these patterns detected a geographic gradient, with the largest difference occurring between the northern Bering Sea (Little Diomede I.) and the eastern Gulf of Alaska (St. Lazaria I., near Sitka). These differences may be due to regional differences in atmospheric and oceanic transport processes and food webs. Other differences found between organochlorine residue levels in Common and Thick-billed Murre eggs might also be due to differences in prey types and wintering areas used by the two species.

Steroid hormones in yolk and allantoic waste of Common Murres (*Uria aalge*)—patterns within a subcolony *[Poster]*

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We examined temporal patterns of steroid levels in egg yolk in a subcolony of Common Murres (*Uria aalge*). Most studies of steroid hormones in avian egg yolk address within-clutch variation in hormone levels in terms of its role in mitigating the effects of hatching asynchrony. Later-laid eggs usually contain more androgens (testosterone and a precursor—androstenedione), which can increase growth and aggressiveness of chicks. Although female murres lay only one egg, subcolonies are analogous to multi-chick broods—late-hatched chicks are under pressure to fledge at a younger age in order to be synchronous with their earlier-hatched neighbors. Thus, we predicted higher androgen levels in later-laid eggs within a subcolony. We assessed embryonic exposure to steroids in two ways. First, we compared hormone levels in the yolk of earlier- and later-laid eggs from a subcolony. Later-laid eggs contained significantly higher amounts of androstenedione, but there were no significant differences in testosterone levels. Second, we examined steroid hormone levels in allantoic waste of earlier- and later-hatched chicks from a subcolony. Steroid levels in allantoic waste reflect everything processed by the embryo of both maternal (yolk) and endogenous origin. We found a significant negative relationship between levels of several steroid hormones and hatch date and growth parameters, but no significant relationships with testosterone. These results suggest that murre females do not alter testosterone deposition in yolk with respect to timing of laying, but do alter its precursor, androstenedione.

Linkages between ocean climate variability, prey species, and nestling performance on Rhinoceros Auklets on Triangle Island, British Columbia

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Mechanistic linkages between ocean climate variability and Rhinoceros Auklet (*Cerorhinca monocerata*) nestling diet and performance are examined using a 15 year time series from 1976 and 2001 on Triangle Island, BC. In the 1970s, sea surface temperatures in April were cool but they warmed significantly through tohe 1990s. Temperaturespeaked in 1998, cooled abruptly in 1999 and have since remained close to the long term average. 1204 nestling diet samples were collected during this period representing 17 species of fish from 15 families. Three species accounted for 72% by mass in 11 of the 15 years: Pacific sand lance (*Ammodytes hexapterus*), Pacific saury (*Cololabis saira*). and rockfishes (*Sebastes* spp.), in decreasing order of importance. Growth rate anomalies indicated a wide range of performance across years (2.6 g/day to 9.07 g/day), with poor years of growth being particularly common in the 1990s. Annual growth rates were positively related to fledging mass and fledging success. Nestling performance was closely linked to diet composition. Favorable performance was strongly dependent upon chicks being fed meals composed of a high proportion of sand lance. All measures of nestling performance were positively related to the proportion of sand lance in the diet. Spring sea surface temperatures (SSTs) were also related to diet composition. Annual proportions of both sand lance and Pacific saury declined significantly with an increase in SST. In contrast, the proportions of both rockfish and Pacific herring (*Clupea pallasi*) in the diet increased with increasing spring SST. Our data are consistent with the hypothesis that recruitment to sand lance populations within the foraging range of Rhinoceros Auklets within Triangle Islandis reduced when temperatures are warm. Consequently, chick growth rates decline significantly as spring SST increases.

Using radar to refine marbled Murrelet habitat use patterns in northern California

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A key conservation objective of the Pacific Lumber Company Habitat Conservation Plan is to understand patterns of inland habitat use by Marbled Murrelets (*Brachyramphus marmoratus*). In California, Marbled Murrelet habitat relationships are primarily based on information from Pacific Seabird Group (PSG) protocol inland surveys. However, the use of PSG protocol data to evaluate the conservation importance of lands set aside for Marbled Murrelets remains controversial, particularly when the detection probability may vary among habitats and survey conditions. To understand how audiovisual detections may be related to numbers of birds, we conducted simultaneous radar and audiovisual surveys in northern California at 51 sites that were distributed across a wide range of habitats. We found a strong positive relationship between the number murrelets detected by audiovisual and radar methods. On average, the density of murrelets detections was almost five times greater near the dark unentered old growth redwood stands than in the relatively open canopy residual (partially harvested old growth) stands. In contrast to observations made by audiovisual surveyors, the number of radar detected murrelets did not increase later in the breeding season. Finally, we discuss how this information may refine our understanding of Marbled Murrelet behavior and how it may help land managers identify nesting areas most important for the Marbled Murrelet conservation.

Ornament magnitude in relation to mate choice and body condition in Tufted Puffins (*Fratercula cirrhata*)

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Tufted Puffins (*Fratercula cirrhata*) are rare among seabirds for their high degree of ornamentation. Our purpose in this study was to assess: (1) the role of potential secondary sexual ornaments in mate choice, and (2) whether ornaments reliably indicate adult condition. We documented ornament variation with respect to a mate choice and body condition among breeding Tufted Puffins on Triangle Island, British Columbia. For estimates of ornament magnitude, we used digital photographs to measure the color of adult legs and elaborate head features. Preliminary results suggest that, for both sexes, carotenoid-based ornaments are indicative of body condition and are used in mate choice.

Pelagic foraging areas of Cassin's Auklets and Rhinoceros Auklets breeding on Triangle Island, 1999–2002

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We describe the at-sea distributions of Cassin's Auklets (*Ptychoramphus aleuticus*) and Rhinoceros Auklets (*Cerorhinca monocerata*) breeding on Triangle Island, British Columbia. Between 30 and 40 chick-rearing Cassin's Auklets were marked with small radio transmitters in early June in each of 3 years: 1999, 2000 and 2001. In early Jul 2002, 40 Rhinoceros Auklets were marked using the same protocol. Telemetry flights were conducted over high altitude (3000 m), large-scale grids to locate the marked birds during the chick-rearing period. Between 75 and 90% of the marked Cassin's Auklets confirmed to be attending the colony were detected at sea each year. In 1999 and 2000, most of the detected Cassin's Auklets were consistently 50–75 km southwest of Triangle Island in waters 1500–2000 m deep. In 2001, however, most birds were 60–90 km northwest of Triangle Island in waters >1500 m deep. In 2002, most of the detected Rhinoceros Auklets were located 50–70 km north of Triangle Island with several birds up to 100 km distant. Reasons for these at-sea distribution patterns and shifts across years remain to be determined but are likely related to variation in distributions, abundance and/or timing of preferred prey. These telemetry results will be useful to managers in delineating a Marine Protected Area (MPA) for the Scott Island group and in assessing the potential impacts of off-shore oil and gas exploration in the area.

Lifetime reproductive success in Western Gulls: optimization or quality effects

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Studies of lifetime reproductive success (LRS) in Pacific seabirds are extremely rare, but critical for understanding the effects of intrinsic and extrinsic factors on the population dynamics of these long-lived species. We examined the role of life history traits in predicting LRS, the total number of chicks fledged per adult, in three cohorts of Western Gulls (*Larus occidentalis*) breeding on Southeast Farallon Island, California, from 1983 to 2002. LRS of 159 individuals from the 1979, 1980, and 1983 cohorts were analyzed; 4 of these birds are still alive and breeding. We examined the effects of age of first breeding, cohort, sex, breeding lifespan (BL), and mean annual reproductive success (MARS) on LRS. BL and MARS were significant predictors of LRS, and together explained the majority of the variance in LRS. However, contrary to previous studies of seabird LRS, and the hypothesis that less productive birds drop out of samples as they age, BL and MARS showed significant quadratic rather than linear relationships with LRS. LRS increased initially with greater BL, plateaued for a BL of ~12–13 years, then decreased slightly for the greatest BLs. The highest LRS and BL values also were associated with an optimal MARS of fledging an intermediate brood size. In other words, breeders who lived the longest and were the most fecund breeders, on average, did not show the highest LRS values. These results indicate that Farallon Western Gulls may be optimizing annual reproductive success and breeding season longevity in relation to survival tradeoffs. Alternatively, birds showing a long BL may do so because they are poor breeders and rarely incur the costs of chick-rearing.

Brood size affects adrenal responsiveness of free-living Black-legged Kittiwake chicks *[Poster]*

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Birds secrete corticosterone in response to perceived stressors, which in turn functions to facilitate individual survival through modulation of behavior and physiology. Because secretion of corticosterone is linked to nutritional state and sibling aggression, and brood reduction of Black-legged Kittiwakes (*Rissa tridactyla*) is linked to low forage

availability, we hypothesized that 1) breeding success of adult Black-legged Kittiwakes would inversely correlate with their levels of plasma corticosterone; and 2) both baseline and adrenal responsiveness of individual Black-legged Kittiwake chicks would be inversely correlated with their status in the nest (third chick > Beta > Alpha > singleton) and brood size (3 chicks > 2 chicks > 1 chick). In a field study in Chiniak Bay, Kodiak AK (2001 & 2002) we monitored breeding success and collected blood from adult Black-legged Kittiwakes during late incubation for measurement of baseline levels plasma corticosterone. In 2002, we sampled blood for analysis of baseline and stress series levels of corticosterone from 10-day old Black-legged Kittiwake chicks of 1, 2, and 3 chick broods. Productivity (chicks fledged/nest attempt) in 2001 was significantly greater than in 2002 (0.71 vs. 0.48, respectively; $P = 0.028$) and baseline levels of plasma corticosterone of adult kittiwakes were, as we predicted, inversely related to productivity, averaging 1.46 ng/ml in 2001 and 2.23 ng/ml 2002 ($P = 0.040$). These data suggest that Black-legged Kittiwakes in 2002 may have experienced forage limitations during incubation. Contrary to our prediction, baseline levels of plasma corticosterone of kittiwake chicks in 2002 (4.41 ± 0.70 ng/ml) did not significantly differ among chicks of different status (singleton, alpha, beta, tertiary) or among chicks occupying nests of different numbers of occupants (1, 2, 3). As predicted, adrenal responsiveness of chicks to acute stress varied according to brood size with 3-chick broods exhibiting the most rapid and profound increases in corticosterone followed in rapidity and magnitude by 2-chick and 1-chick broods, respectively. However, adrenal responsiveness to acute stress did not vary according to chick status. These data suggest that all chicks of a multi-chick brood regardless of status experience more stress than do singletons and the amount of stress perceived by multi-chick broods increases with number of nest occupants.

Effects of the Juan de Fuca eddy and upwelling on seabirds off southwest Vancouver Island, British Columbia

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Densities of seabirds measured year-round over the continental shelf off southwest Vancouver Island, British Columbia, Canada were compared with meso-scale averages of sea surface temperature. The fixed-strip transect (110 km total length) was divided into six legs (lengths 14–30 km) to sample different shelf habitats. Three foraging guilds were recognized: divers (dominated by Common Murres *Uria aalge* and other alcids), surface-feeders (dominated by California Gulls *Larus californicus* in summer, and other gulls year-round), and shearwaters (mainly Sooty Shearwater *Puffinus griseus*). Sea temperatures showed strong seasonal trends. During winter and spring (mid-Dec through mid-Jun) all six legs had similar temperatures in each survey. During summer and autumn (mid-Jun through mid-Dec), however, temperatures differed consistently by 1–2° C among the six transect legs. Cold surface temperatures were associated with wind-induced upwelling on the inner shelf and the effects of the strong eddy over the Juan de Fuca canyon. Bird densities matched this trend. Densities in winter and spring were low and did not differ significantly among the six legs for any species or guild. Densities in summer and autumn were higher for most species and all guilds, and many species showed significant differences in density among the legs. High summer/autumn densities were consistently associated with the inner shelf edge bordering the Juan de Fuca canyon or over the canyon. Cold temperatures alone did not explain the distribution of seabirds; inner shelf areas more than 15 km from the canyon had cold summer temperatures but low seabird densities. Upwelling associated with the canyon edge appears to produce the most productive foraging for seabirds. Identifying associations of seabirds with meso-scale bathymetric and physical ocean processes is important because these processes can be monitored using satellite imagery. In the event of a major oil spill, which is likely off southwest Vancouver Island, critical areas for seabirds can be rapidly identified and monitored using satellites.

Application of densities derived from radar surveys in the management of Marbled Murrelet habitat

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Five studies in British Columbia have compared the numbers of Marbled Murrelets (*Brachyramphus marmoratus*) entering watersheds from the ocean with the areas of old-growth forest within these watersheds. Radar was used to count the murrelets, and GIS and forest-cover maps were used to assess areas of habitat within watersheds. These studies were on the west side of Vancouver Island (Clayoquot Sound: n = 17 watersheds; Northwest Vancouver Island: n = 20), and on the British Columbia (BC) mainland (Sunshine Coast: n = 19; Central Coast: n = 17; and North Coast: n = 22). All five studies reported significant correlations between murrelet counts and measures of habitat area. Linear and power curves best fit the data, depending on study area and definition of suitable murrelet habitat used. Using the habitat most likely to be used (as defined in each study) we calculated murrelet densities (birds per ha of suitable habi-

tat). Densities differed significantly between the two West Vancouver Island studies (mean 0.082 ± SD 0.034 birds per ha; n = 37 watersheds) and the three BC Mainland studies (0.028 ± SD 0.019; n = 58), but the differences within each of these large regions were not significant. The overall mean for all 5 studies was 0.049 ± SD 0.037 birds per ha. The application and limitations of these density data in management and conservation of murrelet nesting habitat are discussed. It is obviously essential to use the same measure of habitat to derive the density estimate as is used to determine the area of habitat needed for a specified murrelet population, but in practice this is often difficult. The reliability of the method would also be improved if common measures of habitat suitability were applied to each data set.

Seabird monitoring data: how are they used to suggest conservation actions and to evaluate ecosystem processes?

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Most long-term seabird monitoring programs have stated objectives that relate to one or both of the following: (1) conservation of one or more species of seabirds, and (2) using the response of seabirds as a reflection of changes in the marine ecosystem. The idea implicit in goal 1 is that time-series on vital rates (e.g., population trends and productivity) will describe "normal" variability and alert us to potential problems for the species. Goal 2 is meant to evaluate responses of seabirds to fluctuations in their environment thereby helping to explain the ecosystem processes involved and ultimately suggesting causes of observed changes in birds. These goals have been accepted as justification for funding various programs in the past 30 years, and multiple-decade data sets are beginning to accumulate for a number of species and sites. Even more support seems to be gathering for long-term monitoring, and such programs are becoming institutionalized.

Using monitoring data for the conservation of seabirds includes detecting trends that suggest populations may be threatened with extinction. For example, population data coupled with knowledge about threats were used in the process of listing Marbled Murrelet (*Brachyramphus marmoratus*) and Xantus's Murrelet (*Synthliboramphus hypoleucus*). Declines of other species are documented, but we are not aware of a standard way of deciding when population declines are serious enough to "raise the flag" of concern. Neither is it always clear who is responsible for noticing significant indications of problems. Is it the individual investigator who works with the data set, or is it the responsibility of an agency? Just as PSG and some of its individual members have played an important role in the monitoring programs and listing process for the murrelets, we might be even more proactive in helping to develop guidelines for assessing the biological significance of changes in different species for various vital rates. In any case, it seems important to make advances in monitoring data interpretation to facilitate its usefulness for conservation purposes.

Using monitoring data to help to explain ecosystem processes implies that covariates are being measured as well. Events like El Niño provide a basis for gauging short-term responses. Also, physical characteristics are being measured such as sea temperature, weather variables, and indices (e.g. the North Pacific Index) that integrate physical variables. Nevertheless, there are scale mismatches relating to some of the broad-based physical measures, and an important gap exists in time series for primary productivity and prey abundance for most areas in the North Pacific. We do not know of an easy solution to data gaps, but PSG and its members may have an important role to play in advocating for such monitoring systems.

The *Prestige* oil spill in Spain *[Poster]*

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The oil tanker *Prestige*, carrying a cargo of 77 tons of heavy bunker oil, sank off the coast of Galicia (northwest Spain) on 19 November 2002. As a result, several hundred oiled seabirds were collected from hundreds of kilometers of oiled beaches during the first few weeks after the ship sank. Seabird distribution in the offshore waters of Galicia has not been studied well, and as a result, the impact of this spill on vulnerable populations is difficult to predict. Preliminary data on the identification of oiled carcasses suggests that the most numerous victims (in decreasing order of abundance) have been: juvenile Razorbills (*Alca torda*); winter visitors), adult Atlantic Puffins (*Fratercula arctica*; winter visitors), adult European Shags (*Phalacrocorax aristotelis*; residents), adult Northern Gannets (*Morus bassanus*; passage migrants), and juvenile Common Guillemots (*Uria aalge;* winter visitors). By 23/24 Nov 2002, it was estimated that over 80% of Yellow-legged Gulls (*Larus cachinnans michahellis*) seen in coastal Galicia were oiled, but relatively few of these were found dead or were received in rehabilitation centers. We will present seabird mortality data for birds collected and pro-

cessed during the initial weeks of the spill. In addition, we will discuss how this event dramatically illustrates the need for (1) an effective European oil spill contingency plan and (2) subsequent impact assessments for wildlife.

Assessing the risks to Marbled Murrelets from a proposed wind turbine generation project on Rumble Ridge, Vancouver Island

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The growing interest in wind power generation in coastal areas of the Pacific Northwest raises the problem of collisions with seabirds, and whether or not the potential for collision with towers and wires poses risks to populations, especially for rare species. We used high-frequency marine radar to count Marbled Murrelets (*Brachyramphus marmoratus*) flying across a proposed site for wind turbine electrical generators on Rumble Ridge, near Port Alice on northwest Vancouver Island. Radar counts supplemented with audiovisual surveys were done at four stations spanning the proposed wind farm, at dawn and dusk from 22 to 26 Jun 2002. Murrelets were detected at all stations but rain prevented accurate counts at two stations. Overall, we estimated that 50–100 murrelets flew along and over the ridge at dawn during the peak of the breeding season. Few of these murrelets appeared to nest within or near the areas scanned, and most were evidently headed to nesting areas elsewhere. Concurrent audiovisual surveys at the radar stations recorded no murrelet detections. The murrelets flying along the ridge represent 0.63–1.25% of the estimated northwest Vancouver Island population (~8000 murrelets). The number of murrelets nesting in the watersheds surrounding Rumble Ridge is not known, but a small percentage of the regional population is expected to nest in those watersheds. We assessed risk of collisions with turbines and wires by considering the height at which murrelets typically fly, numbers of murrelets, flight paths and the area covered by the rotating turbine blades. Experience at other wind projects suggests that some birds might come into contact with turbines. We suspect that very small numbers of murrelets may collide with turbines, but many uncertainties exist. Even if murrelets do collide, it is impossible to assess impact to local populations without knowing the size of those populations. A post-construction monitoring program is required to reliably estimate rate of collisions, and data on the origin and numbers of birds passing by the site are needed to estimate risk to local populations. The lack of data on local populations, the difficulty in obtaining those data for a species such as Marbled Murrelet, and the uncertainties regarding the ability of murrelets to avoid collisions with turbines highlights the challenges of assessing risk pre-construction.

The influence of food availability on life history parameters of Parasitic Jaegers in Shetland

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Several studies have shown that seabirds seem to have a certain amount of "spare" time and that this can be used to buffer against environmental perturbations. Increases in breeding effort, such as increased foraging effort could lead to the effects of food shortage on breeding success or chick growth being masked by changes in the seabirds' behavior. However, life-history theory predicts that individuals will only increase their present breeding effort if this does not decrease their probability of survival or of breeding successfully in later seasons.

Parasitic Jaegers (*Stercorarius parasiticus*) breeding in Shetland feed predominantly by kleptoparasitism, stealing sandeels (*Ammodytes*) from Arctic Terns (*Sterna paradisaea*), Black-legged Kittiwakes (*Rissa tridactyla*), Atlantic Puffins (*Fratercula arctica*) and Common Murres (*Uria aalge*). During the 1980s the sandeel stock around Shetland declined dramatically and caused widespread breeding failure of many of these seabird species. Recruitment of sandeels increased during the 1990s, but during the 2001 and 2002 breeding seasons there seemed to be a similar shortage of sandeels in the waters around Foula, effecting most of the seabirds nesting there. Empirical data suggest a strong influence of sandeel stock size on Parasitic Jaeger breeding success.

This paper examines evidence that food shortage contributed to the poor breeding success in the Parasitic Jaeger colony on Foula by looking at the effect of a supplementary feeding experiment. Various parameters were measured for the control and experimental groups of birds including attendance on the territory, chick growth rates, breeding success, condition of the adults and return rate to breed the following season, which has been shown to be a good indicator of survival rate. The analysis of these measurements allows us to gauge the impact of food availability on the different parameters and predict the long-term effects on the Parasitic Jaeger population.

Adult body condition in terms of protein stores was measured using a pectoral muscle index. This was obtained by taking the pectoral muscle profile and various body measures and calculating the pectoral muscle volume corrected for the size of the bird. A more general measure of condition was also obtained from body mass corrected for size. Birds were caught during incubation at the beginning of both the 2001 and 2002 seasons and during chick rearing in the 2001 season.

Feather samples were taken from chicks in the control and experimental groups for stable isotope analysis. The

stable isotope signatures for sandeels and the supplementary food (cat food) are very different, enabling us to quantify the amount of supplementary food that is incorporated into chick tissues.

Results of these studies will be presented to test the hypotheses that (a) breeding success is constrained by food supply and (b) seabirds allocate resources as a tradeoff between reproduction and survival.

Distribution patterns of Common Murres *Uria aalge*: underlying behavioral mechanisms in the context of predator-prey theory

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Although distribution patterns of seabirds at sea have been described for decades, it remains difficult to identify the mechanisms underlying these patterns. For instance, researchers focusing on prey distribution as the primary determinant of seabird distribution have found high variability in the spatial overlap of bird and prey aggregations, partially due to the scale-dependent nature of such associations. We conducted a study to identify the behavioral mechanisms that underlie distribution patterns of Common Murres *Uria aalge* on multiple spatial and temporal scales, while murres act as central-place foragers during chick-rearing. The study was conducted on and around Funk Island, the largest colony of murres in eastern Canada (~400,000 breeding pairs), situated on the northeast coast of Newfoundland from 1998 to 2000. Due to high energetic demands during chick-rearing, we focused on elucidating search strategies used by murres to locate aggregations of prey, primarily capelin *Mallotus villosus*. To do this, we quantified (1) individual- and population-level arrival and departure behavior of murres from the colony via colony- and vessel-based observations in combination with (2) direct measurements of the distribution, abundance and spatial and temporal persistence of capelin aggregations within foraging ranges from the colony (~100 km). Directions of return and departure flights of murres measured from the colony did not match during the same period, indicating that murres departing the colony did not use information on prey distribution provided by the flight paths of returning flocks of birds to the colony (Information Center Hypothesis). High-abundance aggregations of capelin were found to be persistent within specific 2.25 km areas ("hot spots") for up to two weeks within one year, suggesting that murres could use memory to locate hot spots on a coarse scale (1–100 km). Specific commuting routes (regular flight paths) of murres toward and away from hot spots were obvious at sea, and feeding murres consistently marked the location of capelin schools within hot spots. This provided excellent conditions for murres to locate capelin schools on both coarse- and fine- (1–1000 m) scales by cueing to activities of conspecifics (local enhancement). Further studies in this area (2000–2002) revealed that hot spots of capelin are persistent among years due to habitat selection by capelin for suitable demersal spawning sites. Therefore, throughout a lifetime in this region, marine predators could learn the locations of hot spots, resulting in the use of traditional feeding grounds through generations. These hot spots of predators and prey allow the maximization of energy transfer among trophic levels in complex marine food webs. Human predators also tend to concentrate fisheries activities within these areas and, thus, there is an eminent need to identify hot spots for protection to maintain the stability of large-scale ecosystem processes.

Eider migration and collision potential and Northstar Island, Alaska

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We used ornithological radar and visual sampling to determine factors affecting eider migration and collision potential at British Petroleum's Northstar Island, an artificial oil production platform located offshore in the Beaufort Sea. We also evaluated the effects of an anticollision lighting system in repelling eiders from the island. Eider (*Somateria* spp.) migration rates were pulsed and were affected by date, precipitation (higher during no precipitation), and winds (higher with tailwinds than all other wind types). Velocities (highest with tailwinds) and flight directions (variable with relative wind direction) were affected only by winds. Flight behaviors were consistently directional and were affected only by moon phase and visibility (highest proportion of nondirectional flight behavior occurred around the full moon if it was not visible). Island-passing success was not affected by any factors, but passing distance was greater during poor visibility and when winds were not calm. Eiders flew farther from the island when anticollision lights were on, but the response was not pronounced. Eiders flew at a mean altitude of 8 m (i.e., at altitudes low enough for collision) and exhibited no fine-scale behavioral responses to the island. These preliminary results suggests that, although the anticollision lights caused changes in spatial distribution that increased avoidance of the island, the amount of change that they caused was small.

A century-long decline in $\delta^{13}C$ in an Arctic seabird: monitoring the consequence or cause of climate change

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Decadal decreases of $\delta^{13}C$ in the tissues of Bering Sea marine mammals have been interpreted as a sign of de-

creases in primary productivity in the last half century. While variation in $\delta^{13}C$ in marine biota can be related to changes in rates of primary productivity, it can also occur in response to changes in the isotopic composition of the source carbon in the atmosphere or ocean, or in the case of mobile upper trophic level consumers, changes in distribution. Black Guillemots (*Cepphus grylle*) are an arctic seabird that winters on the Bering-Chukchi shelf in and next to the pack ice. Feathers obtained from museum specimens and live birds from 1898 to 2002 provide a record of $\delta^{13}C$ for the western arctic that is twice that examined in marine mammals. The feathers reveal a century-long decrease in $\delta^{13}C$ from approximately –16.5 ‰ at the end of the 19th century to approximately –18.0 ‰ in contemporary birds, with the decrease accelerating in the middle of the 20th century. The magnitude and timing of this change is similar to that found in atmospheric $\delta^{13}C$ over the same period. The latter is attributed to increases in emissions of anthropogenic CO_2 which is depleted in $\delta^{13}C$. Arctic biota will be among the first to show the affects of climate change because warming in the region is occurring sooner and faster than at lower latitudes. Additionally the snow and ice habitats that dominate the region can respond directly to changes in air and sea temperature. However, while increasing climate variability can be expected to modify marine productivity and the distribution of marine organisms in the region, it appears that much of the decrease in $\delta^{13}C$ on the Bering-Chukchi shelf can be attributed to changes in the composition of atmospheric carbon caused by increasing anthropogenic emissions of CO_2.

Are you what you eat? Fatty acid analyses of seabirds and their prey *[Poster]*

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Fatty acid analysis (FAA) is a relatively new procedure that is being used to examine animal diets. The main principle of FAA is that dietary fatty acids are deposited in adipose tissue with very little alteration. As a result, predator fatty acid signatures should be similar to the signatures of their prey. Adipose tissue accumulates in animals over time, thus this method can be used to infer diet composition over a longer time scale than gut content analysis alone. As part of a multi-year study, we are examining the impacts of seabirds on out-migrating salmon smolts in the mid-Columbia River using gut content and fatty acid signature analyses. From Apr to Aug 2002 we sampled adipose tissue and gut contents of Double-crested Cormorants (*Phalacrocorax auritis*), Caspian Terns (*Sterna caspia*), and Ring-billed and California Gulls (*Larus delawarensis* and *L. californicus*) collected from the Rock Island Dam tailrace and select breeding colonies within the larger region. This sample set will give us the ability to compare and contrast predators with their prey, birds collected at different distances from the river, as well as a range of life history characters (e.g. age and sex).

The North Pacific Pelagic Seabird database (NPPSD): status, examples, and progress towards integration *[Poster]*

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The need for comprehensive geographic data on the pelagic distribution of seabirds has long been recognized. Although there are a large number of datasets with detailed information on the pelagic (at-sea) distribution of seabirds in the North Pacific, integration of these datasets has been lacking. In a collaborative effort between the U.S. Geological Survey, U.S. Fish and Wildlife Service, National Marine Fisheries Service, Canadian Wildlife Service, North Pacific Marine Research Institute, and many independent investigators, we are compiling available data on the distribution of seabirds (and marine mammals) at sea. These data are being archived in raw form, and are to be combined using a relational database. Tools for analyzing and mapping the data are under development, and we will create web-based and hard copy products for dissemination of the data to scientists, resource managers and the general public. Pelagic seabird distribution data can be used to: model, measure or predict immediate and long-term impacts of oil pollution on marine bird populations; detect and describe long-term changes in marine ecosystems; identify fine- and coarse-scaled features of marine habitats; estimate population sizes of rare or threatened species that are impossible to census using traditional methods; examine seasonal movements and winter habitat use by seabirds; assess potential conflicts between commercial fisheries and marine birds (e.g., longline fisheries and albatrosses); plan and manage marine reserves; and disseminate natural history information to the general public, educators, and the tourism industry. Examples of datasets and preliminary products are provided.

California Least Tern diet and foraging ecology: a comparison between dropped prey and consumed prey *[Poster]*

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The endangered California Least Tern (*Sterna antillarum*) is a piscivorous plunge-diving seabird, feeding on small fishes generally found within the top meter of the water column. We studied the prey choice of Least Terns by collecting two types of diet samples at two breeding colonies in south-central Cali-

fornia: Alameda Point (located on the former Naval Air Station, Alameda in San Francisco Bay) and Purisima Point (located on Vandenberg Air Force Base). We collected dropped fish and feces from Alameda Point during the 2002 breeding season and from Purisima Point during the 2001 and 2002 breeding seasons. For each year at each colony, we stored samples collected during the courtship/egg laying, chick rearing, and fledgling periods of the breeding season separately. We compared species and size compositions between sample types (by analyzing otoliths found in feces) and found that species compositions of dropped fish samples differed considerably by sampling method and site. Prey diversity from dropped fish samples decreased in from the chick stage to the fledgling stage, suggesting that as the chicks grew older, they became more experienced at handling prey and dropped only those items that were extremely difficult to handle. Additionally, prey that dominated dropped fish samples from both the chick rearing and fledgling periods were hardly represented in the fecal samples. The deep-bodied surfperch species (Embiotocidae) were prominent in the dropped fish collections at both sites, while slender-bodied species dominated the fecal samples. Thus, it appears that dropped fish at the Alameda Point and Purisima Point were not surplus prey items and were not necessarily representative samples of Least Tern diet.

Status, abundance, and colony distribution of breeding Pigeon Guillemots (*Cepphus columba*) throughout the inland marine waters of Washington State, as captured by PSAMP efforts 1999–2002 *[Poster]*

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The Pigeon Guillemot (*Cepphus columba*) is the most widely distributed of the alcids that breed within the inner marine waters of Washington State. The Washington Department of Fish and Wildlife and U.S. Fish and Wildlife Service conducted censuses of guillemot colonies in May 1999–2002 to assess their status and population trends in the region. Counts, limited to 3.25 hours after sunrise of any given day, were made from boats at the 120 colonies listed in the Catalog of Washington Seabird Colonies (Speich and Wahl, 1989), and at over 300 other colonies not previously documented; these counts covered all the known guillemot colonies within the inner marine waters of Washington. All colonies were counted regardless of colony size, with replicates on at least 2 to 3 different days. Complete counts of all colonies were made in 2000–2002, as not all colonies had been documented by May 1999. For comparing yearly trends, colonies were stratified into localized areas to limit the bias of birds shifting between colonies between years. The average total count of breeding guillemots throughout the region ranged from approximately 14,000 to 16,000 from 2000 to 2002. Habitat types at each colony were documented to assess their importance to breeding guillemots.

A biogeographic analysis of seabird distributional data from central California

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As part of a biogeographic assessment in support of the revision of the management plans for the Gulf of the Farallones, Cordell Bank, and Monterey Bay National Marine Sanctuaries, we compiled and integrated data from all major seabird distributional studies in Central California since 1980. These included the Minerals Management Service (MMS) Aerial Surveys, Seabird Ecology Study, Rockfish Assessment cruises, Eastern Pacific Ocean Circulation Study (EPOCS) cruises, Office of Spill Prevention and Response (OSPR) overflights, San Francisco Deep Ocean Disposal Site (SF-DODS) cruises, and the National Marine Fisheries Service's Oregon, California, and Washington Line Transect Expedition (ORCAWALE) cruises. These data were used to examine the spatial distribution of all major species in the area relative to season and to El Niño-Southern Oscillation (ENSO) status. We also determined the geographic distribution of biomass and species diversity within the area. A geographically linked principal components analysis was used to delineate habitat types based on similarities in the species assemblages throughout the study area.

Effluent discharges from offshore oil and gas platforms: what are the regulations and the potential impacts to marine birds?

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Alaska, Newfoundland, and countries bordering the North Sea all have offshore oil and gas production and concentrations of marine birds. Here, I focus on how the legal discharge standards for effluents generated by the offshore oil and gas industry varies among regions, and outline the potential impacts these discharges may have on marine birds. Drilling fluids and cuttings, and produced waters are the three major sources of pollutants that are discharged into the ocean in huge quantities. For example, a single platform in production

can average 9,400 barrels/day (1.5 million l/day) of produced water for a twenty-year period. These discharges cover a wide range of pollutants that include heavy metals and petroleum hydrocarbons. The effluents that can have an immediate impact on marine birds are the permissible discharges of oil and grease. Each country has specific restrictions regarding the amount of oil and grease in discharges: Newfoundland is 60 mg/l daily maximum and 30 mg/l monthly average, regulated by the Canadian-Newfoundland Offshore Petroleum Board; the United States (federal waters) is 42 mg/l daily maximum and 29 mg/l monthly average, regulated by the Environmental Protection Agency; and the North Sea countries is 40 mg/l monthly average under the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) guidelines. To put these numbers in perspective, the International Convention for the Prevention of Pollution from Ships requires that vessels cannot exceed an *instantaneous* oil discharge of 25.5 mg/l (15 ppm); quantities greater than 25.5 mg/l result in oil sheens on the water. The U.S. has additional regulations under the National Pollutant Discharge Elimination System that prevent the discharge of free oil. OSPAR guidelines do not appear to have regulations that prevent oil sheens from occurring. The offshore waste treatment guidelines for Newfoundland (and Nova Scotia) also do not have specific regulations that prevent oil sheens from occurring. This means that a platform can create an oil slick and still be in compliance. Of most concern is the Grand Banks, which has some of the world's highest densities of seabirds and the highest permissible discharges of oil of the three regions examined. Unfortunately, the Canadian-Newfoundland Offshore Petroleum Board has a very obdurate attitude towards tightening environmental regulations and more specifically towards the necessity of quantifying the impacts on marine birds from offshore oil activities. I will provide recommendations for improving the regulations, and discuss the data required to model marine bird populations' responses to episodic oil pollution from offshore oil activities.

What lies beneath: how well do surface counts of auklets track numbers of breeding pairs:

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Breeding populations of crevice-nesting Least Auklets (*Aethia pusilla*) and Crested Auklets (*A. cristatella*) are currently monitored throughout their range by counting individuals in plots on the colony surface. This technique is favored because one observer can monitor large numbers of plots and the data are relatively simple to collect and analyze. Counts of adult auklets on the talus surface are assumed to be representative of numbers of active auklet nests beneath the surface, although this assumption has never been tested. Some previous studies have suggested, however, that among-year variation in colony attendance could reflect changes in behavior associated with food availability more than changes in numbers of breeders. We tested the assumption that densities of Least and Crested Auklets on the talus surface are correlated with nesting density below the surface at a colony on St. Lawrence Island in 2001 and 2002. Surface counts on plots that had been covered with tarps to prevent bird access throughout the laying period were compared to counts on control plots during the mid-incubation to mid chick-rearing period. The treatment, which apparently prevented all nesting in crevices beneath the tarps, did not significantly affect the average number of adults subsequently counted on the surface ($P = 0.67$), although counts from treatment plots had higher variance. Colony attendance as indicated by counts on control plots differed between years for both species. Surface counts of Least Auklets were higher in 2002 than in 2001 ($P < 0.001$), whereas counts of Crested Auklets were lower in 2002 than in 2001 ($P < 0.001$). Despite opposite trends in colony attendance for the two auklet species, both species had higher reproductive success in 2002. While surface counts may provide an indication of among-year differences in colony attendance, they do not accurately reflect breeding population size or productivity. Other techniques, such as mark-resighting, show more promise for detecting year-to-year changes in numbers of breeding pairs, and should be used in conjunction with surface counts on fixed plots to assess changes in auklet breeding populations over time.

Reproductive ecology of Glaucous-winged Gulls on Kodiak Island, Alaska *[Poster]*

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Because reproductive success of seabirds is both easily monitored and has been shown to be positively correlated with available food resources, seabirds may be useful indicators of foraging conditions just prior to and during their breeding season. The use of piscivorous seabirds as indicators of forage availability in the nearshore, east side of Kodiak Island, Alaska is integral to the Gulf Apex Predator-prey project (GAP). Reproductive variables of seabirds that are sensitive to the influence of food supply include but are not limited to hatching success, egg volume, and clutch size. In 2001 we initiated a multi-year study of the reproductive ecology of the Glaucous-winged Gull (*Larus glaucescens*) to investigate its utility as an indicator of

local marine conditions. We monitored nests on six different colonies within Chiniak Bay, Kodiak Island and followed their fates on designated plots from nest initiation through hatch. In 2002 we expanded the scope of our research to include an additional colony. Hatching success was significantly different among colonies (χ^2 = 64.91, P = <0.0001), and tended to be higher in 2001 than 2002 (χ^2 = 3.45, P = 0.06, n = 314 in 2001and 330 in 2002). Egg volumes differed among colonies (F = 2.92, P = 0.008), but not between years (F = 0.07, P = 0.79, n = 251 in 2001 and 311 in 2002) and there was no year-colony interaction (F = 1.01, P = 0.40). Mean clutch sizes differed among colonies (F = 6.57, P <0.0001) but not between years (F = 2.92, P = 0.09, n = 314 in 2001 and 330 in 2002) and there was a year-colony interaction (F =2.35, P = 0.04). Because there were significant differences in hatching success, egg volume, and clutch size among colonies, future GAP hypotheses concerning Glaucous-winged Gull research will address and quantify factors that may contribute to those differences, including habitat characteristics, proximity of colonies to food resources, and foraging areas of breeding adults. In addition, we are expanding research on the physiology of Glaucous-winged Gulls and developing methodologies that utilize hematological measures of body condition that may serve as a proxy for breeding success and local foraging conditions in Chiniak Bay.

Assessment of noise disturbance on nesting Marbled Murrelets in Redwood National and State Parks: a progress report on the first two years of study

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In April–May 2001 and 2002 we captured at sea 23 and 44 Marbled Murrelets (*Brachyramphus marmoratus*), respectively, and attached radio transmitters. Subsequently we identified 5 (22% of birds) and 19 (43%) nesting attempts in 2001 and 2002 respectively, that were all within a 42 km^2 area (minimum convex polygon of nest locations) within the Redwood National and State Parks (RNSP). Based on radio-detected attendance patterns, 3 of these nests successfully fledged young in 2001. In 2002, 2 were known to have successfully fledged young (although 6 additional nests had uncertain outcomes and may have fledged). In 2001, we conducted a noise experiment using a chain saw at one of the successful nests during the chick-period of nesting. In 2002 we conducted 7 similar experiments (4 nests during incubation and 3 nests during chick-rearing). For each experiment at each nest we compared behavioral changes (activity, posture) in video recordings of the 30 min pre-disturbance period, a 15 min disturbance with the running chain saw, and for 30 min post-disturbance. We also monitored 3 nests with persistent video to help identify behaviors and assist with determination of nest fates. Ambient noise levels at locations beneath nests were not different than ambient noise levels at random points in the nesting area that we investigated in RNSP.

Seabird-fisheries overlap over time and space: preliminary results from the West Coast Groundfish Observer Program

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The spatial and temporal overlap of seabirds and fishery operations has both ecological and socioeconomic ramifications. The incidental mortality of seabirds such as the Short-tailed Albatross (*Phoebastria albatrus*) can potentially significantly impact population dynamics of these long-lived species as well as severely curtail the operation of fisheries along the entire west coast of North America. Along the coasts of Washington, Oregon and California, breeding and migrating seabirds overlap in space and time with a wide variety of offshore and nearshore fisheries, potentially leading to many seabird bycatch issues. In 2001, the West Coast Groundfish Observer Program began documenting non-target fish, seabird, and mammal bycatch by training and deploying observers on trawl, long-line, and pot-geared vessels in eleven port groups along the Pacific coast from Bellingham, Washington to Santa Barbara, California. During observer trips, the observers record information on date/time of departure, date/time of gear deployment and retrieval, latitude/longitude of gear deployment and retrieval, and gear type. In addition to any seabird bycatch in sampled hauls, observations of seabirds of interest seen during gear deployment and retrieval are reported, including species, number, date/time, latitude/longitude, bird activity, and any tagged or color banded birds. During the first year of observer coverage, the extent of seabird bycatch in samples was limited to two cormorants in one trawler haul. Although bycatch was limited, several species, including those of special concern, were observed during fishing operations throughout the observer coverage area. A number of individual Short-tailed Albatross were observed during hauls in the spring, summer and fall months from areas off the Washington coast to those off Monterey, California; Black-footed Albatross (*Phoebastria nigripes*) were also observed during these months, numbering from one to 150 individuals. The spatial and temporal overlap of seabirds and fisheries and the potential seabird bycatch issues along the west coast of North America require ex-

tensive observer coverage and methodologies. In the future, we hope to more effectively estimate this overlap by adding seabird observation protocols that will more explicitly quantify seabird distribution and abundance with respect to fishing operations covered by the West Coast Groundfish Observer Program.

A physiological approach to determine reproductive status of waterfowl: applications for sea duck research and conservation *[Poster]*

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Conservation of North American sea ducks is inhibited by a lack of knowledge regarding basic biology, as well as effective population monitoring techniques. We describe a non-lethal method to determine reproductive status of waterfowl, based on elevated blood plasma concentrations of the two main yolk precursors vitellogenin (VTG) and very-low density lipoprotein (VLDL) during rapid follicle growth (RFG). To test the applicability of this method for waterfowl, we characterized the dynamics of VTG and VLDL concentrations in female Greater Scaup (*Aythya marila*) during the breeding cycle on the Yukon-Kuskokwim Delta, Alaska. From 19 May to 21 Jun 2002, 58 females were collected, resulting in a data set comprised of individuals representing all reproductive stages, including prebreeding, RFG, laying, and incubating. Yolk precursor concentrations were evaluated in relation to follicular development determined by dissection. Circulating concentrations of VTG and VLDL were significantly different between discrete reproductive stages. Mean concentrations were low in prebreeding birds (0.71 µg/ml and 3.96 mg/ml, respectively). VTG concentrations increased rapidly during RFG to a mean of 3.35 µg/ml for birds with a full follicle hierarchy, while VLDL concentrations increased only slightly during RFG to a mean of 6.75 mg/ml for birds with a full follicle hierarchy. Yolk precursor concentrations remained high through the laying stage and then decreased rapidly at clutch completion with the onset of incubation. Our results for VTG are consistent with other studies in passerines, although our results for VLDL dynamics indicate that at full follicle development concentrations are almost threefold lower in scaup than has been reported for passerines. Our work indicates that the dynamics of plasma VTG are a more reliable index of egg production than VLDL in waterfowl. This technique is a potentially powerful tool that can be used to develop a more detailed knowledge of factors related to sea duck productivity.

Diet of the Xantus's Murrelet in southern California *[Poster]*

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Little is known about the diet of Xantus's Murrelets *(Synthliboramphus hypoleucus).* Based on radio telemetry studies, they are known to forage far from the breeding colony and from shore, but prey and feeding behaviors are not well understood and difficult to observe. Prey are not visibly held in adults' bills during feeding, highly precocial chicks depart from the nest at 2-3 days old without being fed by parents, and night-captured murrelets at breeding colonies have empty stomachs (based on lavage and endoscope techniques). The most knowledge about diet is from direct examination of stomach contents of 22 murrelets collected in May 1977 by Hunt et al. (1979) near Santa Barbara Island, California. Prey consisted of primarily larval northern anchovies (*Engraulis mordax),* as well as other fish. To increase knowledge of diet and help interpret at-sea distributions (using radio telemetry) of murrelets in 1995–97 and 2002-03, we collected 10 murrelets south of Anacapa and Santa Cruz Islands, California, in May 2002. Prey consisted of juvenile northern anchovies, unknown fish (family Centrolophidae or Stromateidae), Euphausiidae, and unidentified fish bones. This small sample confirmed the continued importance of northern anchovies and other fish, but also shows that they feed on invertebrate euphausiids. Xantus's Murrelets appear to exploit a variety of prey species in southern California during the breeding season.

Male-female differences in parental care in Little Auks (*Alle alle*) *[Poster]*

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Understanding differences in male and female care among closely related species that share biparental breeding systems can provide insights into the selective pressures that shape parental strategies. Among seabirds, the Alcidae (auk family) are particularly appropriate for this approach, since they exhibit wide variation among species both in parental care at the colony and post-fledge and in chick developmental strategies. However, the roles of males and females in parental care remain incompletely understood for some alcid species. The Little Auk (*Alle alle*) is an important example, because unlike other alcid species that have semi-precocial chick development, Little Auk chicks do not fledge independently, but are instead accompanied to the sea by one parent. Despite this in-

triguing system of parental care, the details of differences between males and females during chick rearing and fledging have never been thoroughly studied, in part due to difficulties in sexing these birds in the field. Previous studies have shown a male sex bias in captured adults carrying chick meals during late chick rearing, and adults that have been collected while accompanying their fledged chick at sea have been male. However, since there have been no observations on marked, known-sex birds, sex differences in provisioning have only been inferred, and the non-provisioning aspects of parental care remain largely unknown. Using molecular sexing, we examined Little Auk parental care at the colony during the chick rearing and fledging periods by conducting observations on marked, known-sex pairs. There were no significant differences between male and female feeding rates or their time spent at the colony during the early- and mid-chick rearing observation periods. Males delivered significantly more meals and spent significantly more time at the colony than females during late chick rearing. Very few females were present at the colony during the end of the chick rearing and over the fledging period, and all marked parents observed accompanying their chick to sea were male. Although birds in general spent more time in the nest during early chick rearing, males and females did not differ in time spent in the nest during early and middle chick rearing. Very few aggressive interactions were observed. Based on these findings, we present hypotheses on Little Auk parental care in relation to phylogeny and physiological and ecological factors.

Results of inland Marbled Murrelet surveys in the Straits Planning Unit, north Olympic Peninsula, Washington, USA *[Poster]*

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The Washington Department of Natural Resources (DNR) is conducting inland surveys for Marbled Murrelets (*Brachyramphus marmoratus*) to develop an inventory of murrelet use of state forests. Information from these surveys will be used, along with additional knowledge, to develop region-specific, long-term conservation strategies as part of a Habitat Conservation Plan under the U.S. Endangered Species Act. The Straits (of Juan de Fuca) planning unit comprises about 62,500 ha of State Forests along about 200 km of the northern and eastern perimeter of the Olympic Peninsula. DNR studied murrelet habitat relationships there from 1995–1996, which allowed a spatially explicit prediction of DNR-managed forest stands likely to contain 95% of the occupied sites on state lands in the planning unit. The study predicted that this would occur in approximately 6000 ha of generally low to mid-elevation Douglas fir/western hemlock forest. These stands were then scheduled for murrelet surveys. We delineated 289 survey sites located from Lake Crescent, east to the Hood Canal and south to Shelton in the narrow strip of nonfederal land peripheral to Olympic National Forest and/or Park. Sites averaged 20.7 ha and ranged from 0 to 15 km from saltwater. We established 1169 survey stations at these sites, one station per 5.1 ha. Surveys were conducted by a private contractor (Hamer Environmental) from 2000 to 2002. Two-year surveys (n = 2713) for occupancy according to the Pacific Seabird Group protocol found: 60 occupied sites (1370 hectares), 110 sites with murrelet presence only (2366 hectares) and 119 sites with no detections (2251 hectares). Detections were recorded on 374 survey visits (14% of visits). Occupied sites were distributed almost exclusively (n = 57) in the northern and western portion of the planning unit from Lake Crescent to Sequim Bay. In 2003, 19 sites will receive second-year surveys and conclude the inland survey inventory of the planning unit.

Resolving fine-scale environmental patterns using beached bird surveys

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Over the past three years, the Coastal Observation and Seabird Survey Team (COASST) has grown incredibly in its scope—both geographically and in terms of volunteer participation. Presently, over 150 volunteers contribute beached bird and environmental data on at least a monthly basis across 65 sites in Oregon and Washington. Because of this broad expansion, we can now examine trends in deposition, persistence, and scavenging over increasingly fine temporal and geographic scales. In this paper we will discuss some of the surprising patterns that are emerging as result of this increased coverage. For example, in 2002, our geographically comprehensive coverage of the San Juan Islands revealed how extensively oil from an isolated spill or incident might be spread. Six of sixteen COASST beaches reported tarballs during Aug–Sep and the broad extent mimicked the distribution revealed by regional driftcard studies. In another example, direct evidence of falcon/eagle predation on juvenile gulls during fall has been hard to document by conventional observation (such as bill scratches left on the breastbone). However, our data show that a disproportionately high percentage of juvenile gull carcasses are initially discovered as partial (breast missing, 24%) versus intact (complete, 6%). We think that this is due to the immediate loss of the breast meat to a predator, rather than a quicker-than-average loss to scavengers. In comparison, other top-ranking taxa (ones less vulnerable to predation) such as murres and adult gulls are found in nearly equal frequencies in partial and intact condition—suggesting that scavengers find and eat carcasses in proportion to their abundance on the beach. A similar predation signal is also conspicuous in the list of species never found intact: eleven of 15 are shorebirds and ducks, favored prey of Peregrine Falcons. COASST has been able to docu-

ment patterns like the above because we have chosen sampling frequencies and site locations that maximize our ability to discern temporal and spatial patterns without overtaxing our volunteers.

Geographic variation in Pacific Northern Fulmars: are there two subspecies?

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Morphological variation in Northern Fulmars (*Fulmarus glacialis*) has been well studied in the Atlantic, where two subspecies are recognized: a large-billed, monomorphic light-phase form (*F. g. auduboni*) of the boreal zone (e.g. Britain, Faroes, Iceland, Newfoundland) and a small-billed, polymorphic form (*F. g. glacialis*) found in the high Arctic. Pacific fulmars are referred to a single subspecies, *F. g. rodgersii*. The current distribution of color phases suggests a virtual absence of gene flow among the major Pacific colonies, however, and measurements reveal marked variation in body size. Pacific fulmars comprise a small-bodied, mostly dark-phase form in the Gulf of Alaska, Aleutians, and Kurile Islands, and a larger-bodied, monomorphic light-phase form in the Bering Sea and northern Sea of Okhotsk. With one notable exception (Semidi Islands, western Gulf of Alaska), Pacific colonies tend to have only one or the other of two distinct color morphs, both differing in size and plumage from their Atlantic counterparts. Light-phase fulmars at the Semidi Islands (where 85% are dark) are smaller than light-phase birds in the Bering Sea. Thus, at least two subpopulations of fulmars exist in the North Pacific that (a) differ morphologically, (b) have non-overlapping ranges, and (c) show current evidence of highly restricted gene flow. There would seem to be strong justification for recognizing two subspecies of Pacific fulmars. We further suggest that color polymorphism in arctic regions of the North Atlantic stems from introgression of dark-phase genotypes that evolved monophyletically and originally occurred only in the North Pacific.

At-sea movements of radio-tagged Marbled Murrelets off the coast of northern California

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In 2001 and 2002 we captured and radiotagged 23 and 44 Marbled Murrelets (*Brachyramphus marmoratus*), respectively, in coastal waters adjacent to the Redwood National and State Parks complex in Humboldt County, northern California. We used fixed-wing aircraft to track radiotagged murrelets at-sea and in old-growth forest nesting habitats. In both years, 92% of murrelets with active radios were detected per flight. Murrelets typically foraged in near-shore waters (<2 km) between the mouth of Humboldt Bay, CA, and Brookings, Oregon. Minimum convex polygons were larger for murrelets that did not initiate nesting after capture compared to murrelets that did initiate nesting after capture. Minimum convex polygon size varied between male and female murrelets. Maximum north-south distance traveled is also compared between murrelets that did not attend nest sites and murrelets that did attend nest sites after capture, and between males and females (sexed with blood samples).

Environmental predictability, foraging range, and timing of breeding in seabirds: Lack and Ashmole revisited

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Reproduction in birds is often timed to take advantage of peaks in resource abundance in order to maximize reproductive success. Seabirds have evolved two mechanisms to match breeding with peak resource (usually food) abundance: 1) they respond to fine-scale environmental cues that predict future resource availability, or 2) they time their breeding to a rigid annual cycle. Why should birds adopt one strategy over the other? Using a simple computer model of food availability for seabirds with large and small foraging ranges, we demonstrate that species with small foraging ranges have a more unpredictable food supply. The model assumes that for both types of foragers, prey varies on the same spatial and temporal scale, and there are no other differences in foraging ecology. Following the logic of this model, there is stronger selection for small-range foragers to time their breeding in response to the environmental cues that are more immediate predictors of increased resource availability (e.g., sea surface temperature). Because these predictors are often variable in time, we predict that small-range foragers will have a more variable phenology. In contrast, large-range foragers can more effectively buffer against temporary food shortages, which leads to weaker selection for responding to these environmental cues. We predict that large-range foragers will often have a less variable breeding phenology, and are more likely to time their breeding to coarse predictors of peak resource availability (e.g. day length). A comparison between foraging ranges and variability in timing of breeding in the Hawaiian seabirds lends support to this hypothesis.

Associations of seabirds with subsurface predators in Hawaiian waters *[Poster]*

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Tropical seabirds are known to feed in strong association with subsurface predators such as tunas and dolphins. In waters around Oahu, Hawaii, during summer and fall of 2000 and 2001, 74% of these associations were with skipjack tuna (*Katsuwonus pelamis*). Seabirds were also observed feeding with yellowfin tuna (*Thunnus albacares*), mahi mahi (*Coryphaena hippurus*) and spotted dolphins (*Stenella attenuata*). Wedge-tailed Shearwaters (*Puffinus pacificus*) were the most abundant birds in the feeding associations, followed by Red-footed and Brown Boobies (*Sula sula* and *S. leucogaster*), Brown and Black noddies (*Anous stolidus* and *A. tenuirostris*), Sooty Terns (*Sterna fuscata*), Newell's Shearwaters (*Puffinus newelli*), White Terns (*Gygis alba*), and migrating Sooty and Short-tailed Shearwaters (*Puffinus griseus* and *P. tenuirostris*). Sooty Terns and the four species of shearwaters showed seasonal absence from the associations as they migrated out of Hawaiian waters.

Diet and at-sea distribution of Leach's Storm-Petrel *Oceanodroma leucorhoa*: avian planktivores in northwest Atlantic food webs

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Leach's Storm-Petrel (*Oceanodroma leucorhoa*; LESP) is a small (ca. 50g), wide-ranging, highly pelagic planktivorous seabird. The world's largest colony breeds on Baccalieu Island on the east coast of Newfoundland. Despite its being the most abundant breeding seabird in eastern North America, little is known about the species' foraging ecology. This is cause for concern as both fishing activities and oceanographic variations have caused major shifts in pelagic food webs over the Newfoundland Shelf during the 1990s. These changes have had demonstrated effects on reproductive performance and feeding ecology of piscivorous seabirds, but little is known of potential effects on planktivores. This study combines colony and vessel-based research to investigate the foraging ecology and trophic relationships of LESP.

Comparisons are made of parental food samples ($n = 795$) collected at colonies lying within two different oceanographic regions; Green Island off Newfoundland's south coast (1987–88) and Gull Island off the east coast (1988). These samples augment current collections and importantly, allow comparisons before and after the regime shift of the early 1990s. These food samples provide information on (1) occurrence of prey types and species, (2) apportionment by numbers and mass, and (3) the size and mass of prey consumed. Fish and crustaceans formed the bulk of the diet in the late 1980s; fish occurred in 96% of the samples and crustaceans were present in 71%. Fish contributed little by number, but due to their large size they were the major component of the diet. The fish portion of the diet was dominated by myctophids, with capelin *Mallotus villosus* and cod (Gadidae spp.) and also making significant contributions. Hyperiid amphipods and *Hyperia galba* in particular dominated the crustacean portion of the diet. Site, seasonal, and annual variations in prey consumption will be discussed. Ongoing research, using both traditional dietary techniques and fatty acid profiling (see Logan and Montevecchi this meeting), will provide important information on LESP diets in the northwest Atlantic. Such food sampling could also provide potentially useful information on 0-group age classes of some fish species.

Using standard strip transect surveys, the density and distribution of LESP over the Newfoundland Shelf was quantified annually in both May (1999 to 2001) and Aug (1998 and 1999) aboard fisheries research vessels conducting acoustic surveys of capelin. LESPs were typically first encountered 30 km offshore, but densest concentrations were found in the vicinity of the shelf edge and slope waters. Distributions of birds will be analyzed across a variety of spatial and temporal scales, and where possible linked with distributions and densities of prey and oceanographic features. Being widely distributed and functioning at a low trophic level, LESP will provide insight into factors driving changes in both forage fishes and ecosystem-level processes through integration with a larger multi-species complex involving piscivorous seabirds.

Predictability of seabird distributions within the Gulf of the Farallones at various temporal and spatial scales

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Seabird survey design and analysis is often dependent on assumptions about the scale of seabird movement and distributional change. Data that support these assumptions, however, are often not available. This analysis was designed to examine the variability and predictability of seabird distribution at various temporal and spatial scales. During the oil removal operation from the wreck of the *S.S. Jacob Luckenbach*, weekly or near weekly aerial seabird surveys were conducted over a nine-month period by California Department of Fish and Game's Office of Spill Prevention and Response (OSPR) contractors. The survey coverage area included a majority of Gulf of

the Farallones National Marine Sanctuary and the northern portion of Monterey Bay National Marine Sanctuary. From the data collected for these surveys, bird densities were calculated within 1nm blocks and a subsequent pair-wise comparison of densities was done for all blocks. The coefficient of correlation was then calculated for all pairs of blocks falling within 1 nm of each other at a given time step. This was repeated for multiple time steps between 24 hours and 6 months, and for multiple spatial bins between 1 nm^2 and 1000 nm^2 . The densities of Western Grebes (*Aechmophorus occidentalis*), Sooty Shearwaters (*Puffinus griseus*), Brown Pelicans (*Pelicanus occidentalis*), Surf Scoters (*Melanitta perspicillata*), Western Gulls (*Larus occidentalis*), Common Murres (*Uria aalge*), Marbled Murrelets (*Brachyramphus marmoratus*), and Cassin's Auklets (*Ptychoramphus aleuticus*) were each analyzed separately. In general, the predictability of distribution decreased with time for all species, but varied widely among species at a given spatial scale.

Ecology of relaying in Cassin's and Rhinoceros Auklets at Triangle Island, British Columbia

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The relaying ecology of Cassin's Auklet (*Ptychoramphus aleuticus*) and Rhinoceros Auklet (*Cerorhinca monocerata*) was studied at Triangle Island in 2002 by collecting first eggs from early-laying females. Most birds relaid (90% of Cassin's Auklets, and 81% of Rhinoceros Auklets). Among control Cassin's Auklet pairs: (1) breeding success was moderately high (60%) and only very weakly declined with laying date; (2) chick mass at fledging declined with later hatching; and (3) *Neocalanus* copepods dominated nestling diets throughout the season. Among experimental (i.e., relaying) Cassin's Auklets: (1) breeding success was high (68%), and (2) chick mass at fledging did not follow the population-wide seasonal decline. Among control Rhinoceros Auklets pairs: (1) breeding success was low (46%) and declined with later laying, due to a decline in hatching success; (2) fledging mass was unaffected by hatching date; and (3) sandlance dominated nestling diets early in the season, but there was a marked switch to Pacific saury beginning late in July. Among experimental (relaying) Rhinoceros Auklet pairs: (1) breeding success was low (30%), following the population-wide seasonal decline in hatching success; and (2) the few pairs that succeeded had their chicks fledge at normal masses. We conclude that both Cassin's and Rhinoceros Auklets have a high capacity to relay. However, whereas there was little immediate consequence associated with relaying in Cassin's Auklets, consequences were considerable for Rhinoceros Auklets. Possible reasons for the difference will be discussed.

Trends in Marbled Murrelet inland activity in old-growth forests: Olympic Experimental State Forest, Washington, USA

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The Washington Department of Natural Resources (DNR) manages 110,000 ha of state forests on the western Olympic Peninsula, where widespread inland activity of the threatened, forest-nesting Marbled Murrelet (Brachyramphus marmoratus) occurs. DNR conducted 4856 murrelet surveys between 1994 and 2001, recording 7683 detections at 642 sites that comprised 17,200 ha of old-growth forest. I explored annual trends in murrelet activity apparent in these data, to help develop hypotheses useful for developing and monitoring a murrelet conservation strategy. Given a discrete study area and consistent forest stand condition, I hypothesized that inland activity was influenced by oceanographic phenomena and the passage of time. I developed several murrelet activity indices, and obtained monthly average sea-surface temperature (SST) and upwelling data from federal agency internet sources. I reduced the numbers of dependent and independent variables by examining correlations between and among murrelet and oceanographic metrics, and comparing within-sample variability. I selected dependent (average annual total and sub-canopy detections per survey, annual proportion of surveys with detections, and average annual total detections from just those surveys), and independent variables (winter and summer average SST, and year). Multiple regression analyses (all n = 8, i.e. 8 years) suggested that annual murrelet activity was associated with SST and year: both total and subcanopy detections per survey were negatively correlated with year and winter SST; adjusted $r^2 = 0.58$, $P = 0.05$ and adjusted $r^2 = 0.56$, $P = 0.05$, respectively. However, average annual detections per survey are mathematically and, I believe, ecologically a function of the annual proportion of surveys that record any murrelet activity and the average numbers of detections from just those surveys. The annual proportion of surveys that recorded detections was negatively associated with year—adjusted $r^2 = 0.39$, $P = 0.06$; while average detection rate on those surveys was negatively correlated with winter and summer SST—adjusted $r^2 = 0.71$, $P = 0.02$. No DNR-managed old-growth forests were harvested during this study, and results of nearby inland radar and marine counts (both of shorter duration) do not suggest a

population decline. However, the association of detection rates with the passage of time and winter SST suggests a nearly 10% annual decline in activity over the study area, given average winter SSTs. Assuming that murrelets' activity is an index of their attraction to particular forest stands, I hypothesize that inference regarding attractiveness of sites be modified based on the years of survey—i.e., sites studied later were relatively less likely to receive high activity levels, merely because murrelet activity declined with time. Similarly, I hypothesize that estimates of murrelet inland activity for either conservation planning or monitoring purposes should consider influences of oceanographic phenomena.

A digital habitat "fly-through" model-scenario for nesting Marbled Murrelets in desolation Sound, British Columbia *[Poster]*

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The flight path Marbled Murrelets (*Brachyramphus marmoratus*) take from the ocean to their nesting site is not exactly known. However, it is widely believed that most birds fly inland along rivers and bottom valleys, but rarely cross mountain ridges to reach their nests. Here, foraging and resting locations on the ocean are linked to nest sites using least-cost path analysis. The Marbled Murrelet nest data set for Desolation Sound, British Columbia, for the years 1998–2000 from the Centre for Wildlife Ecology consist of 84 georeferenced capture locations and corresponding nest locations determined by helicopter telemetry. Together with a Digital Elevation Model (DEM TRIM1), a least-cost path analysis was calculated in ArcView 3.1 and ArcGIS. For the first time, a digital Habitat Fly-Through Animation is presented for flight paths, as well as for landscape types overflown by birds. Visualized results allow for general flight path characterizations, e.g. length, shared flyways, and how a Marbled Murrelet could perceive the landscape while flying to and from nests. Findings show that specific and commonly used flyways follow rivers and streams. The relevance of the assumptions that birds follow low elevation features and avoid crossing mountain ridges are discussed. In addition, decision rules are hypothesized how murrelets on the water reach their nests. This approach allows to identify relevant nesting areas within 70 km inland when the basic landscape and habitat characteristics are known.

A predictive Marbled Murrelet model using combined marine and terrestrial habitat components for the Canadian coast during the breeding season

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Marbled Murrelets (*Brachyramphus marmoratus*) spend a substantial amount of time in coastal habitats, particularly during the breeding season. This complex habitat is characterized by a terrestrial as well as a marine component and is therefore difficult to describe efficiently. Here we describe Marbled Murrelets' Canadian coastal habitat with the terrestrial and marine component using a quantitative GIS modeling approach across three scales ("bins" of 5, 25 and 50km). For each bin scale, we compiled data on marine bird abundance, nesting evidence, and (occupied) detection surveys. These data sets are linked with over 30 "coastal habitat" predictors to construct the "best" model that characterizes Marbled Murrelets' habitat association during the breeding season. We used an advanced set of habitat descriptors derived from field surveys and GIS data layers. Our results allow for efficient modeling and predicting the linkages between Marbled Murrelets and their coastal habitat. An approach for model and inference assessment is shown. We also present a large-scale eco-classification approach for the coastal Marbled Murrelet habitat in Canada. Our methods and findings are important in deriving valid population estimates and for understanding how coastal habitat affects distribution and abundance of birds during the nesting season. This is for instance relevant for predictive modeling of Marbled Murrelet radar surveys.

Investigations of Marbled Murrelet nesting habitats using a geographic information system (GIS) and radiotelemetry in Desolation Sound and Clayoquot Sound, British Columbia, Canada

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Marbled Murrelets (*Brachyramphus marmoratus)* are Pacific seabirds of conservation concern that nest mainly in coastal old-growth forest trees. However, their habitat features required for breeding are incompletely known. We report on 121 nest sites found in a fragmented forest landscape of Desolation Sound in 1998–2001, and on 36 nest sites from Clayoquot Sound for 2000–2002. We captured and radio-tagged murrelets on the water, and subsequently located nests during systematic aerial searches during the birds' incubation periods. We determined nesting success from aerial survey data, climbed all trees that could be accessed from the ground, and confirmed

the presence of nests and nesting success in all such cases. For Desolation Sound, most nests occurred in Old Forest (>140 years) polygons, as classified on 1:20,000 forest cover maps. However, many nests were found in non-contiguous "Old Forest scrub," small (e.g. 5–20 ha) Old Forest patches, and other classes. We investigated the influence of topographic features on nest site habitat selectivity and nesting success. For Desolation Sound, nests typically occurred on steeply sloped sites (mean 33°, minimum 0°, maximum 70°) at a mean elevation of 748 m °350 SD (median 748 m), and ranging from 38 to 1530 m. These topographic characteristics of nest sites were compared to randomly selected locations in a 50-km radius circle centered at the aquatic capture site, using 1000 random samples generated using a GIS for each analysis. For Desolation Sound, Marbled Murrelets selected nest sites on steeper slopes, even when the topographic distribution of Old Forest habitat was taken into account. Nesting success was higher on steeper slopes and at high elevations. For evaluation, we repeated the same study approach for Clayoquot Sound. Although sample sizes are relatively small, our results are in agreement with findings from Desolation Sound. Nest locations in Clayoquot Sound were found at mean elevations of 569 m ±326 SD (median 614 m) ranging from 29 to 1191 m; the mean slope was 30°, ranging from 4 to 49°. Our results differ from traditional studies that used ground-based approaches to locate nests, which generally imply that murrelets would prefer shallow slopes at lower elevations. We provide several possible explanations for these differences, and suggest that biases in data collection may partially explain them. Our findings should help guide land management decisions designed to protect suitable nesting habitat for this species.

Plumage-based aging criteria for the Black-footed Albatross *[Poster]*

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The accurate assessment of the status of albatross and petrel populations has become a conservation priority, in light of pervasive mortality in longline fisheries. In addition to colony-based counts, at-sea surveys can improve our ability to monitor these populations in a variety of ways. For instance, an improved understanding of the distribution of different age classes can help assess potential population-level impacts of fisheries bycatch. Moreover, changes in population composition can be used to test the predictions of modeling studies, which frequently invoke shifts in the population age structure. However, these valuable insights can only be gained if reliable field aging techniques are developed.

In this paper I describe and assess the utility of plumage-based aging criteria for the Black-footed Albatross (*Phoebastria nigripes*), a vulnerable species according to International Union for the Conservation of nature (IUCN) criteria. First, I quantified the repeatability of plumage assessments using 67 known-age museum specimens. Overall, 95%, 95%, and 100% of the inspected birds were reliably scored into one of three plumage classes. Next, I evaluated the correspondence between these plumage classes and age groups defined on the basis of bursa characteristics: juvenile (birds of the year, 0.5 years), immature (pre-breeders, 1.5–4.5 years), and mature (breeding-age, >4.5 years). There was a generally good correspondence between the age groups and the plumage classes, with 82% and 100% of the juvenile and mature birds belonging to the first and third plumage classes respectively. Immature birds were more difficult to characterize, with 14%, 68%, and 18% of the specimens belonging to plumage classes 1, 2, and 3 respectively. Finally, to illustrate the applicability of the aging criteria described here, I quantified the age composition of the Black-footed Albatross population off southern California (29° to 35° N, 117° to 124° W) from February through December.

I surveyed albatrosses during 19 cruises between Aug 1996 and Apr 2000. Overall, 97% of the 294 birds sighted during surveys were aged using these plumage-based criteria. I combined all birds sighted during a given month and used hierarchical clustering to identify time periods with similar age-class population composition. This analysis revealed four stages: (1) incubation (Nov–December), characterized by the absence of white-rumped (mature) individuals; (2) early chick-rearing (Feb–Mar), characterized by the numerical dominance of juvenile birds and the presence of all age classes; (3) late chick-rearing (Apr–Jun) and post-breeding (Aug–Oct), characterized by the presence of all three age classes and the numerical dominance of mature birds; and (4) dispersal from breeding colonies (Jul), characterized by the absence of juvenile birds.

These observations are in agreement with previous studies of Black-footed Albatross distributions off the West Coast of North America. Banding and telemetry studies have revealed that breeding age birds occur off California between Spring and Fall, and that juveniles are most numerous during Winter. Despite substantial individual variability in molting and bursa involution patterns, this study suggests that plumage characteristics can be effectively used to characterize Black-footed Albatross age classes at sea.

Marine bird response to internal oceanographic variability in a dynamic transition zone: southern California (1997–99)

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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.

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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.

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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.

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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.

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