ABSTRACTS

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Oral Presentation

USE OF DIMETHYL SULFIDE IN FORAGING BY ANTARCTIC SEABIRDS

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Procellariiform seabirds are known for their remarkable sense of smell, but little is known about how these birds use naturally-occurring biogenic aromatics for foraging. In controlled experiments performed at sea, we recently found that several species of Antarctic procellariiforms were attracted to dimethyl sulfide (DMS; Nevitt et al., 1995). However, whether these birds associate at sea with naturally high levels of DMS has not been explored. From 20 March-5 May 1993, we concurrently counted procellariiform seabirds and measured ambient levels of atmospheric and seawater DMS levels as part of a NOAA RITS cruise. Of twenty-eight procellariiform species present in the survey area, blue petrels (*Halobaena caerules*) and prions (*Pachyptila* sp.) were significantly more abundant in areas of high atmospheric DMS concentrations (8.1-12.5 pM/l; $P<0.05$). A significant relationship was not observed between the abundance of procellariiform seabirds and ambient seawater DMS concentrations. Wilson's storm-petrels (*Oceanites oceanicus*) and black-bellied storm-petrels (*Fregetta tropica*) were not associated with elevated atmospheric or seawater DMS concentrations, although these species were highly attracted to DMS in experimental trials. We will examine our findings in terms of known foraging strategies.

25th Anniversary Symposium Oral Presentation

CLIMATE CHANGE AND SEABIRDS: A REVIEW OF TRENDS IN THE EASTERN PORTION OF THE PACIFIC BASIN.

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The distribution, abundance and natural history of Pacific Basin seabirds are sensitive to long-term variation in the atmospheric and oceanographic features that define their habitats. Effects can be direct, such as air temperature increasing stress or energy demands, or indirect, as with water temperatures affecting the distribution and abundance of prey species. While seabirds are constantly responding to modifications in their environment, only recently has the temporal extent of seabird studies and an apparent increased rate of global warming allowed examination of contemporary changes. We present case histories demonstrating the influence of recent climate change on seabirds in the Pacific Basin and adjacent Antarctic and Arctic. In several cases, clear changes are evident. Those at high latitudes are frequently tied to atmospheric changes affecting ice and snow habitats while those at middle and lower latitude are caused by oceanographic shifts. ENSO appears to have facilitated many changes in population size and range, with change coming in a step-wise fashion with each ENSO event. Some changes may be the result of the ending of the little ice age in the latter part of the last century.

Oral Presentation

SPATIAL MODELS FOR SEABIRDS IN MARINE HABITATS

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Marine resource managers increasingly require sophisticated methods to analyze abundance and spatial distribution of marine animals. A geographic information system (GIS) is a robust tool for analyzing spatial relationships but is rarely applied to marine ecosystem analyses. We designed predictive models of seabird distribution and abundance using a geographic information system (GIS). Models were based on the results of logistic and multiple regression analyses of environmental data collected at sea during May-June, 1985-1993. GIS digital data layers contained in the models included depth, sea-surface temperature, distance from the nearest species-specific colony, distance from the shelf-break, and distance from land. We tested model accuracy with an "error matrix" using data collected in 1992 and 1993. Overall, the models performed well for abundant species such as Common Murre but poorly for species that occur in low abundance. Spatial analyses can generate insights into seabird habitat associations which are not possible to discern from the usual statistical analyses.

25th Anniversary Symposium Oral Presentation

MARINE BIRD ECOTOXICOLOGY FOR THE NEXT CENTURY: PERSISTING PROBLEMS AND DEVELOPING TRENDS

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The field of Ecotoxicology is barely 50 years old. Seabirds were among the first wildlife to show adverse effects from widespread environmental contaminants, and concerns during the 1950s-1970s centered on population health. The scientific approach was reactive: studying and remediating problems after they had occurred. Today, many depressed populations of seabirds (with abundant terrestrial examples, as well) have essentially recovered. But in some situations, problems persist because of: (1) continued, uncontrollable inputs and continued persistences of old, recalcitrant contaminants, (2) new data on unforeseen effects involving pollutant/physiological interactions (such as immunosuppressions, hormone disruptions, and contaminant reactions with secondary ecological stressors), (3) ever-increasing development and transport of hazardous materials and their associated accidents, and (4) the continued introductions of new chemicals. Ironically, one of the longest-standing issues, oil pollution, will carry strongly into the next century. New, potential contaminants may come to represent repeats in the lessons supposedly learned from this century. Yet, concerns for seabirds in contaminant situations must still center on the health of populations; and a predictive approach in Ecotoxicology will be necessary, where potential problems are defined before they occur.

Oral Presentation

DIET COMPOSITION, REPRODUCTIVE ENERGETICS, AND PRODUCTIVITY OF SEABIRDS IN THE EXXON VALDEZ OIL SPILL AREA

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Reproduction in seabirds is frequently limited by the parents' ability to allocate energy to the breeding effort. We examined potential energetic factors (diet composition, diet quality, meal size, meal delivery rate) that constrain the productivity of seabirds in the Exxon Valdez Oil Spill area. Lipid contents of fishes varied considerably, resulting in energy densities ranging from 2.0 to 10.8 kJ/g wet mass. Seabirds can potentially experience a five-fold difference in energy intake, based on the type of forage fish consumed. Pigeon Guillemots provisioned their young with both nearshore demersal and schooling forage fishes, while Black-legged Kittiwakes fed nestlings mostly herring, sand lance, and capelin. Higher energy density, larger meal size, and higher delivery rate resulted in higher energy provisioning rates to seabird broods, which influenced productivity. Growth performance of guillemot nestlings at Kachemak Bay declined coincidentally with less sand lance in the diet, whereas kittiwake growth performance was lower with less herring, sand lance, and capelin. This suggests that increased incidence of high quality of prey in the diet appeared to have a significant influence on seabird growth performance and productivity in Alaska.

Oral Presentation

DIE-OFF AND STARVATION OF SHORT-TAILED SHEARWATERS (*Puffinus tenuirostris*) IN RELATION TO PREY AVAILABILITY IN THE EASTERN BERING SEA.

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Large numbers (thousands) of dead seabirds, particularly Short-tailed Shearwaters, were reported floating and washed ashore in the eastern Bering Sea during July and August 1997. In our study of the foraging ecology of Short-tailed Shearwaters during their annual migration to the Bering Sea, we recorded stomach contents and measured the total body mass, lipid content, and pectoral muscle mass of individuals collected prior to (June) and during (late Aug / early Sept) the die-off. In June, specimens contained significantly greater body mass, lipid, and muscle content than birds collected in Aug/Sept. Furthermore, Short-tailed Shearwater diet differed between the two seasons. In June, it consisted almost exclusively of adult euphausiids, *Thysanoessa raschii*. In Aug/Sep, we observed a more diverse diet including juvenile *T. raschii* and *T. inermis* euphausiids, fish paste, and crab zoea and megalops. Most likely, shearwater starvation and mortality were caused by decreased availability of preferred prey. Anomalous physical conditions in the eastern Bering Sea during Summer 1997 were characterized by relaxed winds, decreased mixing along the inner front, and elevated sea surface temperatures. These unusual conditions probably initiated a cascade of perturbations in the food web which decreased the availability of adult euphausiids to shearwaters foraging in nearshore surface waters. This perturbation provided a unique opportunity to study how oceanographic variability disrupts ecosystem structure, and how the disruption of lower trophic levels ultimately affects apex predators such as the Short-tailed Shearwater

Oral Presentation

DETERMINATION OF PREY OF COLONIAL BIRDS: THE CALIFORNIA LEAST TERN AS AN EXAMPLE.

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California Least Terns foraging in and around San Diego Bay, California, consumed mainly bay anchovies and topsmelt of 3-6 cm in length. We determined diet visually, verifying species type and size by fecal analysis. During the beginning of El Ni¤o, the terns switched to sardines and northern anchovies of the same size. We collected dropped fish on the breeding colony and found that the species type as well as the size differed significantly from what the terns actually consumed. Other seabirds such as gulls and other terns regularly flew over the colony, and we suggest that dropped fish were from these birds instead. Thus, using dropped fish as a means to identify what certain species are eating can lead to erroneous results and should not be used.

25th Anniversary Symposium Oral Presentation

SEABIRDS AT SEA: LESSONS FROM THE PAST, PREDICTIONS FOR THE FUTURE

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Although historically, the vast majority of seabird research has focused on that portion of a seabird's life spent on land, the past twenty-five years have been witness to a tremendous increase in efforts devoted to understanding what seabirds do at sea. These efforts have been aided by methodological developments, including increased ability to identify seabirds at sea, due in large part to publication of comprehensive field guides, development of quantitative survey techniques in conjunction with greater numbers of pelagic research cruises, and vast improvements in computer capabilities and statistical methods allowing for quantitative treatment of multiple variables. We are now constructing complete distribution patterns for the world's seabirds and beginning to understand them in terms of habitat correlations and ecological interactions. We are documenting myriad ways that seabirds use to locate and procure prey, investigating their roles in the communities of which they are a part, and integrating these patterns into ecological theory. Finally, we are realizing that the ocean is not the pristine system, immune to anthropogenic effects, as was once thought. Even seabirds in the most remote oceanic regions are subject to a wide array of human-induced disturbances.

Poster Presentation

DISTRIBUTION OF SEABIRDS IN MONTEREY BAY DURING THE UPWELLING AND OCEANIC SEASONS OF 1996 AND 1997

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Recent studies of seabirds have demonstrated the importance of collecting simultaneous environmental and oceanographic data to interpret patterns of distribution and abundance. Monterey Bay is a highly productive ecosystem and supports a diverse array of migrant and post-breeding seabirds during the upwelling and oceanic seasons (May - November). Documentation of seabird distribution patterns within the bay was conducted via 13 shipboard surveys during the upwelling and oceanic seasons of 1996 and 1997. Strip transects of 100m width were surveyed in a random-systematic manner along east-west lines running offshore from the 30 fathom isobath, and spaced every three minutes of latitude. Thirty-three species of seabirds were documented, with Sooty Shearwater (*Puffinus griseus*), Common Murre (*Uria aalge*), and Western Gull (*Larus occidentalis*) most common. Seabird groups differentiated themselves along bathymetric and sea surface temperature gradients. The most pronounced patterns were the occurrence of Common Murre throughout the bay when sea surface temperatures were low and over shallow neritic water as temperatures increased, Cassin's Auklet (*Ptychoramphus aleuticus*) over areas of deep water or steep bathymetry when sea surface temperatures were low, and Pink-footed Shearwater (*Puffinus creatopus*) when sea surface temperatures were elevated.

Poster Presentation

MONITORING BEACHCAST SEABIRDS IN MONTEREY BAY

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In May 1997, a monitoring study of beachcast birds and mammals was established in the Monterey Bay region. During weekly and monthly surveys, trained volunteers systematically searched 47km of sandy beaches along Monterey Bay. The primary goal was to assess trends in the distribution and abundance of beachcast seabirds, and assist the Monterey Bay Sanctuary program with early detection of mortality events caused by natural and anthropogenic perturbations. Secondary objectives of the program were to determine the appropriate sampling frequency for beachcast monitoring, and assess the effects of time-of-day and tidal cycles on deposition rates. During the first six months of the program, the most common beachcast seabirds were Common Murre (*Uria aalge*) and Sooty Shearwater (*Puffinus griseus*). Two significant deposition events occurred: greater than 400 Common Murres were deposited along beaches in the southern half of the bay during late August (cause undetermined), and greater than 400 birds were impacted by a spill event in the northern half of the bay in October. Although designed largely to identify long-term patterns, this monitoring study has demonstrated its usefulness in resource management over a short six-month period.

Oral Presentation

CONSISTENT PATTERNS OF INTERYEAR AND INTER-COLONY VARIATION IN RHINOCEROS AUKLET NESTLING DEVELOPMENT AND DIET ACROSS OCEANOGRAPHIC DOMAINS.

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Interyear variation in developmental patterns of alcid nestlings coupled with nestling diet information can signal variation in prey availability over large spatial scales. From 1995-1997 we investigated Rhinoceros Auklet nestling development and diet at three colonies in British Columbia: Seabird Rocks (off Southwest Vancouver Island) in the coastal upwelling domain, and Triangle Island (off northern Vancouver Island) and Sgan Gwaii (off southern Haida Gwaii/Queen Charlotte Islands) both in the coastal transition oceanographic domain. In all years nestlings of a given wing length were heavier on the most southerly and northerly colonies, Seabird Rocks and Sgan Gwaii, than on the intermediate Triangle Island. Furthermore, on all colonies, nestlings of a given wing length were heavier in 1995 than in other years. Rapid nestling development and large meal size both between years and colonies were associated with high proportions of Pacific sand lance in the nestling diet. We explore mechanistic explanations for the observed large-scale patterns and emphasize the important role for behavioural studies to further understand the response of seabird parents to variation in prey availability and abundance.

Oral Presentation

USE OF TRANSMITTERS IN SIMULATED EGGS AND CHICKS TO MONITOR PREDATION OF ARTIFICIAL MARBLED MURRELET NESTS

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From 1995 to 1997 we placed 512 artificial Marbled Murrelet nests in 49 forested stands on the Olympic Peninsula. We tested the adequacy of artificial nests, using transmitters within simulated chicks and eggs, in detecting nest predation. Each nest contained either a plastic egg or a mounted chicken chick with a movement-sensitive transmitter. We painted eggs to simulate Marbled Murrelet eggs, and dipped transmitters in wax. Transmitters served two purposes: they allowed remote sensing of predation-date (pulse-rate changed after disturbance), and allowed tracking of eggs and chicks that were carried by predators. Wax coating allowed identification of predators at 261 (64 %) of 410 preyed-upon nests. The use of both eggs and chicks allowed detection of a wide range of visual- and scent-oriented predators. Artificial nests were effective at investigating relative predation rates. We advocate the use of wax, transmitters, eggs and chicks, and feel it is important to compliment this work with research on potential predators identified at artificial nests.

Poster Presentation

CONTAMINANTS IN CANADIAN ARCTIC SEABIRDS

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Organochlorine levels in eggs of Thick-billed Murres and Black-legged Kittiwakes breeding in the Canadian Arctic have been monitored since the mid-1970s. During 1993, eggs and chicks of Thick-billed Murres, Black Guillemots, Northern Fulmars, Black-legged Kittiwakes and Glaucous Gulls were collected from several colonies throughout the Canadian Arctic including one site sampled since the mid-1970s. Species were chosen to represent a variety of trophic levels and feeding habitats. Egg contents and chick carcasses wee analyzed for organochlorines including PCB congeners, as well as mercury, selenium, cadmium and lead. The highest residue levels of organochlorines were found in Glaucous Gulls. Geographical differences in residue levels were found between high and low Arctic Thick-billed Murres, and high and western Arctic Glaucous Gulls. Differing overwintering areas and feeding habits may explain some of the differences found. Comparisons of residue burdens in the eggs with chick body burdens indicates that all species were picking up cadmium, mercury and selenium from food in the local environment. Comparison of 1993 egg residue data with data from the mid-1970s and mid-1980s from the same colony shows that PCB and DDE levels have decreased in Thick-billed Murres and Black-legged Kittiwakes.

Poster Presentation

NATAL PHILOPATRY AND GENETIC STRUCTURE IN BREEDING POPULATIONS OF HARLEQUIN DUCKS (*Histrionicus histrionicus)*

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Sex bias in natal philopatry should influence expected relatedness among individuals and genetic structure of breeding populations. Members of the philopatric sex should be more related to one another than members of the dispersing sex. Moreover, spatial proximity of related individuals may promote the development of dynasties in which related individuals associate socially, and which may in turn influence survival and reproductive success of group members. Although Harlequin Ducks of both sexes are reported as showing approximately 50% adult philopatry to breeding streams, no male natal philopatry has been reported, whereas female philopatry is confirmed in several areas. Using variation at microsatellite loci of Harlequin Ducks captured on breeding streams in 1996 and 1997, we assessed patterns of relatedness within breeding subpopulations in the Pacific population. By comparing these patterns within and between sexes, we evaluated the extent of sex bias in natal philopatry. This study provides insight into factors influencing population genetic structure, as well as information that may influence decisions on management of breeding populations.

Poster Presentation

VARIATIONS IN COMMON AND THICK-BILLED MURRE CHICK DIET IN RELATION TO CHANGING PREY AVAILABILITY AT THE GANNET ISLANDS, LABRADOR

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The past decade has witnessed drastic changes in the abundance and distribution of many fishes common in the diets of seabirds breeding in Eastern Canada. Capelin, which historically predominated Common Murre chick diet at the Gannet Islands, Labrador, virtually ceased spawning on Labrador beaches during the early 1990s. Fifteen years after previous researchers studied Common and Thick-billed Murre chick diet at the Gannet Islands, we revisited the islands to assess changes in murre productivity, feeding rates, chick diet composition and diet quality (as measured by energy density and fat content of prey). During the early 1980's, capelin accounted for approximately 75% by number of Common and 25% of Thick-billed Murre chick diet (Birkhead and Nettleship, 1987). In 1996 capelin comprised only 15% and 2% of the chicks' diets. Concomitant with a slight increase in capelin abundance in southern Labrador in 1997, capelin comprised nearly 50% of Common and 5% of Thick-billed Murre chick diet. The relative paucity of capelin in the murres' diets in the 1990's accompanied an increase in diet overlap: both murres primarily fed their chicks daubed shannies. Despite interyear differences in diet composition, murre productivity, feeding rates and diet quality remained unchanged.

25th Anniversary Symposium Oral Presentation

BEHAVIOUR OF INDIVIDUAL BIRDS AT SEA: A REVIEW OF THE LA GRANGIAN APPROACH TO SEABIRD FORAGING ECOLOGY

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We review the foraging ecology and time-energy budgets of birds at sea, focusing on the behaviour of individual birds rather than populations or communities. The past 25 years have produced massive advances in theory, technology, and empirical knowledge, but many aspects of the lives of birds at sea remain poorly known. The reliable use of seabirds to monitor ocean environments remains the holy grail. Advances in theory (e.g., central place foraging, provisioning concepts, variable time buffers) and technology (e.g., activity data-loggers, radio- and satellite telemetry, time-depth recorders, and doubly-labelled water) have allowed greater understanding of the constraints of time and energy on breeding seabirds. The ecology of non-breeding seabirds remains a daunting challenge. Research on underwater foraging has begun to answer important questions on the abilities and limitations of diving birds, in a productive blend of conceptual modelling, physiology, remote-sensing technology and field ecology. Recent technology has revealed prodigious feats of flight and diving in many seabirds. We take a global view in reviewing concepts and technology, but focus on North Pacific species for advances in empirical knowledge.

Poster Presentation

DIVING BEHAVIOR OF RADIO-TAGGED MARBLED MURRELETS IN CENTRAL CALIFORNIA

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Concurrent with a radio telemetry study in central California, dive times were collected for Marbled Murrelets from May to July 1997. Dive times (n=789) and surface recovery times (n=763) were recorded for 44 diving bouts of 16 murrelets. Mean dive time was 24.8±12.2 (SD) seconds, (1-59 range); mean surface time was 14.1±9.7 (SD) seconds, (1-88 range). Dives were recorded between 05:29 and 21:12; the longest dives occurred during midday. Twelve complete diving bouts were recorded from three birds. Mean bout length was 18.1±3.9 (SD) minutes, (9-24 range). Mean number of dives per bout was 26±16.1 (SD), (11-58 range). Mean dive and surface times are comparable to previous results in the literature. In conjunction with other data on radio-marked murrelets, diving data allow a better understanding of daily foraging patterns in central California.

Oral Presentation

MOVEMENT PATTERNS AND HABITAT PREFERENCES OF MARBLED MURRELETS IN CENTRAL CALIFORNIA: A RADIO TELEMETRY STUDY

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Telemetry studies of Marbled Murrelets have been hampered by the difficulty of capturing birds and finding nest sites, and by short duration of tracking ability. Our study utilized capture and attachment techniques which have proven successful for Xantus' Murrelets. We studied movements, at-sea habitats, and nest sites from May-September 1997. Forty-one murrelets were captured (28 radio-marked) in 7 nights of effort from May-August in Año Nuevo Bay. Sex ratio from blood samples was 16 females:25 males. In May-June, 81% of the birds had brood patches (n=26). Four inland nest sites were located in old-growth forests. Identified predators were peregrine falcon and red-shouldered hawk. Two murrelets exhibited long range movements of 181 km south, and 224 km north of Año Nuevo Bay. We tracked radio-marked birds for a mean of 47 days. Health and genetic makeup will be assessed through blood analysis.

Poster Presentation

TRENDS IN POPULATIONS OF MURRES AT BREEDING COLONIES IN ALASKA

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Populations of Common and Thick-billed Murres have been monitored at a number of breeding colonies in Alaska since the mid-1970s. Time-series began earlier than the mid-1970s at a few colonies. We analyzed trends at all colonies with at least 5 counts in the past 25 years to evaluate geographic patterns of change. It appears declines occurred prior to the mid-1980s at several colonies in the northern and southeastern Bering Sea, but numbers have remained stable or increased at these sites since that time. In the western Aleutians, murre numbers have increased since the mid-1970s, but have remained relatively stable in the past 5 years. No overall trends have been detected at colonies in the Gulf of Alaska, outside the trajectory of oil from the *T/V Exxon Valdez* oil spill. At colonies in the spill zone, such as the Barren Islands, numbers of murres recently appear to be starting to increase following the spill.

Oral Presentation

TWENTIETH CENTURY OIL SPILLS AND COMMON MURRE MORTALITY IN CENTRAL CALIFORNIA

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Oil pollution has impacted the central California population of Common Murres throughout the twentieth century. Extensive oil mortality in 1917-1925 contributed to population decline along with commercial egging and human occupation of colonies. The 1937 *Frank H. Buck* oil spill killed thousands of murres from the already severely-depleted population. The 1971 San Francisco oil spill killed 900-3,000 birds from a larger population that had been increasing since the late 1950s. From 1971-1986, assessments of murre mortality and population status improved substantially from efforts by Point Reyes Bird Observatory, Ecological Consulting, International Bird Rescue Research Center, and University of California. The 1984 *Puerto Rican* and 1986 *Apex Houston* oil spills killed about 1,500-2,000 and 6,300 murres, respectively. Oil mortality contributed to population decline from 1982-1989 along with gillnetting and El Niño. From 1985-present, efforts by several state and federal agencies have greatly enhanced continuing efforts to document the effects of oil pollution on Common Murres.

Poster Presentation

MULTI-SCALE INVENTORY AND RESEARCH TO CONSERVE MARBLED MURRELETS IN CLAYOQUOT SOUND, BRITISH COLUMBIA

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Clayoquot Sound on Vancouver Island, an area of high-profile forest conflicts, supports one of the largest breeding concentrations of the threatened Marbled Murrelets in North America. Research on murrelets began in 1995 in response to recommendations from the government's Scientific Panel on forest management “to ensure that particular species known or suspected to be at risk are monitored and their habitats protected.” Our goal was to quantify the importance of the Sound, and habitats within the Sound, for Marbled Murrelets, at a full range of spatial scales over multiple years. At the regional level, boat surveys estimated marine densities and distribution of the murrelets, to compare with other regions and track population trends. At the watershed level, we used radar to count murrelets entering each watershed and correlated these numbers with large-scale vegetation and topographic parameters. At the stand level we conducted standard audio-visual surveys to determine occupancy and to compare detection frequencies with macro and micro-habitat parameters. Detection data combined with ecosystem classification were used to rank and map habitats of importance to Marbled Murrelets. The results are being applied in delineating protected habitat and management zones in Clayoquot Sound, and other coastal areas of British Columbia.

Poster Presentation

FEEDING RATES AND FOOD HABITS IN A SUCCESSFUL MARBLED MURRELET NEST IN WASHINGTON

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Little is known about the feeding habits and chick provisioning of breeding Marbled Murrelets. Most of the available information has been obtained from the Gulf of Alaska and British Columbia, with little understood about food habits in the southern portion of its range. During the 1997 breeding season, a video camera was mounted at an active murrelet nest, during the nestling stage, at Ruby Beach, Washington, located on the Olympic Peninsula. Activity at the nest was recorded from 21 July until fledging on 3 August. Time lapse and real-time recordings were both utilized in 8mm and VHS formats. These recordings, still undergoing analysis, provide information on the frequency of feedings, prey type, and size class of food delivered to the chick. Image quality affects the ability to identify prey to the species level. More information on food habits is needed to help in the conservation of the murrelet and marine resources.

Oral Presentation

MARBLED MURRELET STUDIES AT DESOLATION SOUND, BRITISH COLUMBIA.

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This overview will put in perspective the other presentations at this conference on the long term population study of Marbled Murrelets, which is being carried out at in the Desolation Sound area on the mainland coastal area of British Columbia. After an exploratory period of three years, a long term analysis of the population of Marbled Murrelets began in 1994. The aim was to catch and individually mark birds during the breeding period as an additional tool in understanding both population dynamics and reproductive performance of the species. We coupled this with a detailed nesting area study in the nearby Bunster Hills, in order to get a more complete picture of the requirements of the species during the breeding season. Almost 800 birds have been caught and banded since the start of the project, using mist-net and more recently dip-net catching techniques. The recapture of more than 90 of these birds allows us to calculate local survival rates. For the first time this year we were able to catch and mark juveniles soon after their arrival in the inlets. Birds were sexed using a DNA technique which enabled us to identify possible sexual differences in behaviour patterns and distributions. One banded bird was recaptured more than a year later c.200 km from the banding site, and yet again at the original banding site in the following summer. This is the first record to our knowledge of the distant recovery of a banded Marbled Murrelet. Sixty-two nests have been found during the study, mainly by observations in the breeding season and by post-season tree climbing.

Poster Presentation

EVALUATING THE MARBLED MURRELET SURVEY PROTOCOL WITH RADAR

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We compared concurrent radar and audio-visual observations during 37 mornings in 1997 to help evaluate the Marbled Murrelet forest survey protocol. Each morning, radar data were collected on all murrelet targets that passed over the area surrounding an audio-visual observer, who transmitted their information on murrelet detections to the radar lab in real time, using radio. For each observation, we determined whether radar, audio-visual observer, or both had detected the murrelet. Preliminary information suggests that 16% of murrelet movements in and out of nesting stands occur before official survey start time (i.e., prior to 45 min before sunrise). Because of the dark conditions and because apparently the birds that flew in early were silent, a very small proportion (<2%) of these “early” birds were detected by the audio-visual observer. For the entire morning, preliminary data suggest that over half of all murrelets were missed by audio-visual observers. The proportion of birds that were double-counted by audio-visual observers was low (3%). Murrelets can be detected by audio-visual observers at distances up to 700 m, depending upon local topography and background noise levels. We discuss the implications of our results for interpreting data collected using the standard survey protocol.

Oral Presentation

USE OF RADAR AS AN INVENTORY AND MONITORING TOOL FOR MARBLED MURRELETS IN WASHINGTON AND OREGON

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Concurrent radar and audio-visual observations of Marbled Murrelets were made in 4 drainages in the Olympic Peninsula and in 16 drainages along the Oregon coast during 1996 and 1997. The reliability of distinguishing murrelets from other species on the radar was high, but we caution that radar observations should be accompanied by visual observations to verify species identification at all new sampling locations. A consistent peak in landward movements into nesting areas occurred ~30-60 min before sunrise, followed by a seaward exodus that ended ~1 h after sunrise. Radar counts of murrelets increased steadily during the summer, with mean counts nearly tripling between May and July, then dropping to low levels in August. Day-to-day variation in radar counts in May through July was lower for counts of landward targets (Mean CV = 32% and 10%) than for seaward targets (46% and 15%) in Washington and Oregon, respectively. Based on this range of variation, it would take 6 years (if CV was 10%) to 18 years (if CV was 46%) to detect a 10% annual change in numbers with 90% confidence and a = 0.05. We discuss the implications of our results for designing a murrelet population monitoring strategy.

Poster Presentation

PROVISIONING RATE VARIABILITY IN TUFTED PUFFINS.

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Provisioning rate of Tufted Puffins at Triangle Island, British Columbia, Canada were studied by analyzing mass increments of the chicks. Mass changes measured three times during the day (SUM) were an estimate of burrow food loads. Twenty-four hour mass increments (NET) were used to estimate the number of burrow loads per day. Half of the chicks were supplementary fed after daily mass was measured to discover if adults adjusted their burrow food loads. Chicks were harnessed or burrows were screened to collect burrow food loads. These were used to compare with the mass incremented estimate, as well as to identify what the Tufted Puffins were feeding their chicks.

Oral Presentation

BREEDING PERFORMANCE OF BLACK-LEGGED KITTIWAKES IN RELATION TO FOOD AVAILABILITY: A CONTROLLED FEEDING EXPERIMENT

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To determine if food availability is responsible for the chronic breeding failure of Black-Legged Kittiwakes on Middleton Island, AK, we supplementally fed non-captive adults and nestlings herring *ad libitum* in 1996 and 1997 at a large artificial breeding colony on an abandoned radar tower. By manipulating food supply we addressed three questions: is food limiting their productivity, at what stages of the breeding season are the effects of food limitation most evident, and which parameters of breeding performance are most sensitive to food supply? The tower provided a uniquely accessible colony for experimentation allowing 144 nest sites to be installed with sliding, one-way glass windows and feeding tubes permitting us to closely monitor a series of breeding parameters in treatment and control pairs. Treatment groups were designed to contrast the three identified stages of breeding (prelaying, incubation, chick-rearing). Productivity of pairs supplementally fed through chick rearing exceeded both the control pairs and other treatment groups in both years. This study indicates that kittiwakes are most sensitive to food limitations prior to chick hatching. Further investigation into adult survival will allow an examination of the costs of reproduction in food stressed versus unstressed parents.

Oral Presentation

USE OF SATELLITE TELEMETRY TO LOCATE KING EIDER FALL-STAGING AND MOLTING AREAS.

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Satellite transmitters were implanted in eight male and two female King Eiders captured between 19 - 22 June 1997, on their nesting grounds on Victoria Island, NWT. They were subsequently relocated by satellite every three days. The males left the nesting grounds by 2 July, spent most of July off Baillie Islands and Banks Island in the eastern Beaufort Sea, spent several days in early August off Icy Cape, and arrived on their molting grounds in mid August. The females started migration in mid August, each stopping for a few days at Baillie Islands and Icy Cape and arriving on their molting grounds in the first half of September. Of the nine eiders with functioning transmitters, only one remained in the Chukchi Sea to molt. The rest molted in the Bering Sea, widely distributed along the Russian coast from Mechigmen Bay south to the base of Kamchatka Peninsula, and in Bristol Bay off Alaska. Aerial surveys conducted on 29 September and 3 October in the vicinity of each of the two implanted birds in Bristol Bay, produced conservative estimates totalling 13,469 King Eiders.

Poster Presentation

SOURCES OF RECRUITS DURING COLONY GROWTH: WHY THE MODELS GOT IT WRONG

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The relative contribution of locals and immigrants to colony growth is important to the development of both metapopulation theory and damage assessment and restoration. Two hypothetical models of colony growth for a nest-site limited seabird have been published. Both assume immigration is highest during rapid growth and stops completely when local production is sufficient to account for the observed rate of growth. I studied colony growth at a Black Guillemot colony where all fledglings have been banded since 1975. The relative contribution of local birds and immigrants to annual recruitment was monitored from 1978 to the present. Immigrants comprised 92% of recruits during rapid colony growth decreasing only slightly (to 87%) during a period of slight or no growth. In a period of colony decline, immigrants comprised 60% of all recruits. My findings indicate that the hypothetical models made a number of unwarranted assumptions about dispersal processes that resulted in underestimating the importance of immigrants. These included assuming that: 1) all local birds recruit at the natal colony when nests sites are not limiting, 2) local birds have a recruitment advantage over potential immigrants, 3) potential immigrants are only attracted to a colony when there is a surplus of nest sites.

Oral Presentation

IS COLONY PHILOPATRY IN SEABIRDS BEING OVERESTIMATED?

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Fidelity to the natal colony is generally assumed to be high in seabirds. Researchers typically obtain estimates of colony philopatry by banding fledglings at one location and monitoring their return and recruitment. Colony philopatry is the percentage of the estimated number of fledglings surviving to breeding that recruit at the natal colony. Philopatry rates obtained in this way are typically assumed to be innate. Almost no studies of colony philopatry attempt to examine alternative regional recruitment opportunities or the effects of conditions at the natal colony. Without such information it is impossible to separate regional from colony philopatry. Because colonies chosen for banding studies are frequently the largest in a region, observed colony philopatry can be expected to be high even if recruitment is random within a much larger area. Accurate assessment of the spatial extent of philopatry is needed both for assessing the benefits of philopatry and developing credible damage assessment and restoration plans. The relative importance of regional and natal recruitment opportunities to colony philopatry in the Black Guillemot will be discussed. Published information on colony philopatry will be reconsidered in a regional context.

Poster Presentation

FISH-HOLDING BEHAVIOUR IN MARBLED MURRELETS: AN ESTIMATE OF BREEDING POPULATION SIZE?

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Observations of Marbled Murrelets holding fish in their beaks may be strong indicators of birds about to depart to feed young, and thus may serve as measures of the proportion of individuals with nestlings in a population. Using boat surveys, we investigated how fish-holding in Marbled Murrelets in Theodosia Inlet, British Columbia, changed with time of day and group size during mid-July to early August, 1996. The proportion of murrelets holding fish fluctuated between 0-15 % between 0500 to 1659 h, then rose sharply to 30 % (SE = 4 %) between 1700 and 2100 h. We also found marginally significant evidence that single murrelets holding fish were seen more frequently on the water than pairs or in groups (3. Does this reflect the true proportion of murrelets with nestlings near Theodosia Inlet? We discuss how observations of Marbled Murrelets holding fish may overestimate or underestimate this important demographic parameter.

Oral Presentation

ECOLOGY AND ERADICATION OF NORWAY RATS ON LANGARA ISLAND, QUEEN CHARLOTTE ISLANDS.

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Introduced Norway rats contributed to the decline of Ancient Murrelets breeding on Langara Island (3,200 ha), British Columbia. Using funds from the litigation settlement of the Nestucca oil spill, Environment Canada eradicated Norway rats from Langara Island and its associated islands. Work crews placed an individually-marked plastic bait station at every 75-100 m on a grid over the entire island (1 station/ ha). Bait stations were loaded with wax baits containing 50-ppm brodifacoum, an anticoagulant poison, and monitored every 48 h. Missing baits were replaced to maintain a constant number of baits per station. Rats removed bait for 26 days, after which crews placed baits in plastic bags in each bait station. These were left and monitored for 2 years, after which bait stations and remaining bait were removed from the island. The eradication appears to have succeeded. Rats were not trapped over ~ 400 trap-nights after poison campaign. Feeding activity by rats was not found on apples or oil-dipped chew sticks. Rats were detected around the lighthouse and fishing lodges in January 1996, but since then have not been detected. Measures must be taken to prevent reintroduction of rats to Langara Island.

SYMPOSIUM INTRODUCTION: TWENTY FIVE YEARS OF SEABIRD STUDIES

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This symposium is designed both to look back over the advances in the study of seabirds during the last 25 years and to set a course for the next 25 years. Where has the study of seabirds moved forward; where has it lagged. What are the prospects for the future? The papers are designed both as reviews and as efforts to convey the excitement of each field. If the symposium is successful, it should serve not just as a summary of where we have been, but as an agenda and an invitation to students, to a new generation, to make the next quarter-century as productive and exciting as this one.

25th Anniversary Symposium Oral Presentation

AFTERWORDS: SEEING THE SEABIRDS FOR THE SEA

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The last 25 years have seen extensive advances in seabird biology; however, this progress has been variable. Some fields of seabird biology remain essentially data-driven and descriptive. In extreme cases, these subfields have ignored revolutions in paradigms developed for other organisms. At the other extreme, other seabird fields have adopted theories even before there were many seabird data. Theory has then focused research and driven the use of new methods to test theories. Finally, as in the case of genetics, new methodology has rescued what had become a languishing field. In the future, technology will probably provide an excess of data. Internet communications will make these data universally available. Seabird biology may become more like physics and oceanography: the data are abundant, but good questions are scarce. To ask good questions, we need to pilfer theory from other fields, no matter how distant, as well as to develop a theory of seabirds: asking "what are the underlying generalities about seabirds and their responses to their environment of land, sea and air?" We have made a good start, but the best may be yet to come.

Oral Presentation

DIET IN A GULL HYBRID ZONE: ARE YOU WHAT (OR WHERE) YOU EAT?

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Unlike other hybrid zones in which diet has been studied, there is very little difference in morphology among individuals in the Western Gull/Glaucous-winged Gull hybrid zone. Instead, ecological and behavioral factors may lead to differences in diet among pairs within the hybrid zone. In this study, I: 1. tested for differences in diet based on variation among nesting habitats and reproductive stages and; 2. compared diet of gulls in the hybrid zone to that of the parental species in allopatry. Within the hybrid zone, percent occurrence of the four major prey types differed among habitats. Occurrence of fish increased from incubation to post-hatching for all pairs. Diet composition between pure Western Gull and hybrid pairs did not differ. Diet variation likely resulted from different disturbance regimes among nesting habitats. The percent of pelagic foods taken by gulls in Grays Harbor was greater than that of most Glaucous-winged colonies and less than that of all Western Gull colonies, making diet of gulls in Grays Harbor intermediate.

25th Anniversary Symposium Oral Presentation

APPLICATION OF MATHEMATICAL AND COMPUTER MODELS TO SEABIRD ECOLOGY: A STATUS REPORT

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The application of mathematical and computer modelling to seabird ecology is concentrated in three major areas: (1) foraging behavior, (2) energetics, and (3) populations. Our understanding of the distribution and availability of prey resources has in-creased greatly, and this is reflected in models of habitat selection and foraging behavior. This new information needs to be better integrated into the traditional central place/optimal foraging paradigm to take into account the variable and patchy distribution of prey. Energetics modelling benefits from improving information on metabolism and energetic costs, although the basic modelling techniques have not changed appreciably for some time. Population modelling has evolved significantly in recent years, taking into account interacting sub-populations as well as environmental stochasticity. Population models are limited by the availability of long term data and the difficulties of quantifying linkages between environmental variables and demographic responses. Models of seabird biology are increasingly used to address conservation questions, including oil spill effects, population stability, and the environmental causes of population declines. The greatest promise for future work lies in the increased availability of computer time, computer expertise, and software. To best utilize these advances, modelers should try to make their computer programs available to other interested researchers.

Poster Presentation

INTERSEXUAL VARIATION OF PARENTAL CARE IN CRESTED AUKLETS AT BULDIR ISLAND, ALASKA.

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Crested Auklets are a monogamous, sexually monomorphic species with biparental care, with sexual differences in parental roles during chick rearing. In 1996 we began using radio telemetry to investigate patterns of parental attendance during the chick rearing period. In 1997 we tagged eight pairs, including two males captured during the incubation period. We examined male and female feeding rates and attendance on a weekly basis throughout chick rearing. Females fed chicks at higher rates during the first two weeks after hatching. We also examined crevice attendance (min/day) and found that males were spending almost twice as much time at the crevice compared to their mates during the first two weeks. Taken together, these results confirm that male and female Crested Auklets provide different types of parental care during the first half of chick rearing; females putting more effort into providing food for the chick, while males guard and brood. In 1997, pairs spent more time at the crevice than what we observed in 1996, which may indicate that food was more readily available in 1997.

25th Anniversary Symposium Oral Presentation

CONTRIBUTIONS OF MOLECULAR GENETICS TO UNDERSTANDING SEABIRD ECOLOGY AND EVOLUTION

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Since the biological characteristics of a species are products of its history, understanding a species' evolution is central to understanding its ecology. Initial progress in studies of seabird evolution was slow due to methodological limitations: estimates of gene flow depended on band returns, which are difficult to obtain; the only genetic markers available for study were a few morphological polymorphisms; and the fossil record was notoriously poor. However, recent molecular developments are enabling major advances in the study of seabird evolution. Firstly, they can yield direct insights into such aspects of seabird ecology as parentage and the demographic structure of colonies. Secondly, they can reveal mechanisms of evolution by enabling measurements of evolutionary forces. Thirdly, they can provide accurate reconstructions of evolutionary relationships, which can then be used in comparative studies. And fourthly, they can contribute to seabird conservation. Research in all of these areas is challenging many traditional ideas. For example, monogamy may not be as widespread as previously thought, gene flow among colonies may be extensive, and individual colonies may not be the appropriate units for conservation. Many potential applications of molecular genetics to seabird ecology and evolution remain unexplored, and possibilities for future studies are virtually unlimited.

25th Anniversary Symposium Oral Presentation

POPULATION DYNAMICS AND LIFE-HISTORY STRATEGY RESEARCH ON SEABIRDS

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With high adult survival rates, deferred breeding and low reproductive rates, seabirds look like the ultimate K-selected species. However, classical life-history theory, invoking stable or ephemeral habitats, does not fit seabirds well. Instead, foraging range seems the most promising factor to explain the demographic characteristics of seabirds. Created by Lack and Ashmole, the foraging range theory of seabird life-histories was developed, and mainly accepted, on the basis of inter-species comparisons, especially between pelagic (long-lived and laying a single egg) and nearshore species (lower adult survival and laying multi-egg clutches). The main exceptions to inshore/ offshore generalizations are the penguins, which carry greater food loads than flighted birds; the precocial murrelets, which do not feed their young in the nest; and the *Brachyramphus* Murrelets, which breed far inland from the coast. The theory remains a successful generalization about seabird demography, and one of the most powerful among those relating life-history strategies to ecology. However, perhaps because of its success and obvious validity, it has attracted little research to elucidate mechanisms by which life-history strategies have evolved and been maintained. Moreover, the *Larus* gulls, with high adult survival and a constant 3-egg clutch remain an enigma in search of an explanation. In addition, adaptive reduction in clutch and brood size, resulting in low reproductive rates and combined with high adult survival has population consequences that include strong damping of population fluctuations and delayed response to changes in environmental conditions. These have hardly been explored, either in theoretical or empirical terms. This paper traces ideas about life-history evolution in seabirds, in the context of Lack's generalization about the importance of food in population regulation. I examine the evidence that seabirds are limited by food supplies, either in winter or summer, and the relationship between food-limitation and life-history strategy, and point to directions for future research on seabird life histories.

Poster Presentation

AGE STRUCTURING IN AN EXPANDING THICK-BILLED MURRE COLONY

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The breeding sites of Thick-billed Murres (*Uria lomvia*) banded as chicks, that have recruited to the colony at Coats Island, northern Hudson Bay over the past 8 years were mapped in 1997. This mapping reveals that in established breeding areas, where sites have been occupied since the mid-1980s, recruitment of cohorts occurs randomly, most recruits being at least six years old. In contrast, on recently colonised areas, there is marked segregation by cohorts, with a high representation of birds that were 4-6 years old at the time when the area was colonised. This pattern gives rise, in some areas, to an age structuring within the colony that would be undetected in the absence of birds of known age. As age has a strong effect on many aspects of breeding biology, the possibility of age-structured colonies must be born in mind when selecting sites for biological monitoring or research activities, especially if the colony is known to have expanded recently. At stable colonies the effect is less likely to be of importance.

Oral Presentation

EFFECT OF A STORM ON CHICK GROWTH IN LATE-NESTING BLACK NODDIES

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Birds nesting late in the breeding season often have poorer success than earlier breeders, sometimes due to weather. I studied chick growth and mortality in late-nesting Black Noddies on Heron Island, Australia. When adults were feeding nearly-fledged chicks, a week of strong winds and rough seas (associated with nearby cyclone) apparently made foraging difficult. Chicks which fledged before the storm fledged on-time, but fledging was delayed in 36% of chicks, for up to 3 weeks past average age of 44 days (recorded earlier that season). Nestlings typically exceed adult weight, then lose weight 1-2 weeks before fledging. When the fledging period was extended, weight loss continued, thus average fledging weight was significantly lower (82 g) than in on-time fledglings (95 g). While body weight decreased in delayed-fledging chicks, wing and culmen growth slowed but continued, ceasing in a few just before fledging or death. Storm-related food-stress did not greatly increase mortality: 7% of nearly-fledged nestlings at time of storm (n = 55) soon died of exposure or starvation; earlier that season, mortality rate of nearly-fledged nestlings was 4% (n = 76). Slowing growth while extending the fledging period may be an adaptive response enabling nestlings to survive large, unpredictable fluctuations in their food supply.

Oral Presentation

A MARK-RECAPTURE TECHNIQUE FOR BEACHED BIRD SURVEYS

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Beached-bird surveys are often used to document seabird mortality and compare temporal and spatial patterns of mortality. During the summer of 1997, we conducted beached-bird surveys along a 27-mile stretch of beach on the outer Washington coast and initiated a mark-recapture study to test the feasibility of using such a technique. To follow individuals, we marked beached-bird carcasses using unique combinations of colored cable ties on the bill, wings and/or legs. On subsequent surveys, birds were noted as new or marked. Data taken included species, age (adult, sub-adult, juvenile, chick), a condition index (degree of scavenging or decay), evidence of brood patches, carcass weight, and relative height on the beach. We marked over 1800 carcasses from June 14 to August 13. There were differences among species in both deposition and persistence on beaches. Common Murres composed 79% of the bird carcasses, and larger carcasses were scavenged or buried less than others. Given estimates of deposition and persistence, short-term mark-recapture studies may be useful for estimating long-term temporal and spatial patterns of mortality, especially when human or financial resources are scarce.

Oral Presentation

TOURISTS AND SEABIRDS ON THE GREAT BARRIER REEF

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The Great Barrier Reef Marine Park and World Heritage Area is amongst the largest multiple use marine parks and is the largest World Heritage site in the world. Twenty two species of seabirds nest on 80 islands within the Park. By year 2001 most of the islands will be within daytrip range of urban centres. The ecological impact of visitors on tropical seabirds remains unquantified. At present, there is no scientific justification limiting visitation to seabird islands. Current monitoring schedules over most of the Great Barrier Reef are generally unable to establish if populations are decreasing or increasing. In those cases where trends are detected, as at Michaelmas Cay and the Swain Reefs cays, the cause is not determinable. Two studies now address the issue of visitor impacts on seabird populations. In one, the breeding success of bridled terns is compared between two control colonies and three colonies which receive simulated tourist disturbance. The other will quantify birds' response to tourists' presence as a function of distance between the tourist area (which will be spatially manipulated) and the nesting birds. Preliminary results will be presented.

Oral Presentation

MARBLED MURRELET HABITAT SELECTION IN THE WESTERN OLYMPIC PENINSULA, WASHINGTON

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We examined habitat selection of the Marbled Murrelet utilizing use versus availability analyses and described the characteristics of Marbled Murrelet nests on the Olympic Peninsula, Washington. Nests were found in 1996 (n=4) and 1997 (n=15) by intensive, systematic tree climbing in 3 sites of varying age and tree species composition. All potential nest trees in thirty random plots (40 meter radius) containing approximately 650 trees were climbed. Habitat variables were measured and analyzed at four hierarchical scales at nest and non-nest sites; including stand, plot, tree, and limb/platform levels. Western Hemlock trees (n=18) appeared to be selected for nesting, with no nests located in Western Red Cedar, Sitka Spruce, or Silver Fir. One nest was located in a Douglas Fir on the north side of the Olympic Peninsula where Douglas Fir is often the sole dominant tree species. Preliminary results indicate selection of Western Hemlock trees as nest sites is due to platform quality and higher available cover around nest limbs. This nest tree selection behavior has major implications on how land managers: 1) assess habitat quality; 2) protect nesting habitat; 3) improve habitat quality; 4) develop new habitat and; 5) gauge the contribution of certain forest types to the conservation of the population.

25th Anniversary Symposium Plenary Presentation

SEABIRD STUDY OVER 25 YEARS - PROGRESS APLENTY

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The study of seabirds once involved a dedicated fieldworker, typically equipped with binoculars, bird-bands and notebook who spent several seasons on a remote island. Now it often involves a multi-disciplinary team deploying high-tech electronic devices from which data are downloaded directly onto state-of-the-art computers. This transition has been apparent in my own career which started with observational studies in Galapagos and the Welsh islands and now focuses on one small Scottish island but with close collaboration with molecular biologists, virologists and fishery scientists. The aim of my talk is to review how seabird studies, both world-wide and in the Pacific, have developed over the last 25 years and to assess some of the major advances that have occurred during this time. To achieve this I use the contents list of the major ornithological journals, 17000 references to seabirds in the Zoological Record data-base, a general appeal via the seabird server on the World Wide Web and a poll of delegates at this conference. These indicate that studies on pollutants, birds-at-sea (both distributional survey and the use of telemetry to follow and monitor individual birds), and conservation have become increasingly important whereas those dealing with taxonomy, banding and behavior have fallen out of favour.

25th Anniversary Symposium Oral Presentation

DEFERRED MATURITY IN SEABIRD CONSERVATION AND MANAGEMENT: THE PROMISE AND REALITY OF ENVIRONMENTAL LAW

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There has been a revolution in U.S. environmental law during the past quarter century that establishes a strong legal framework for the long-term protection of seabirds and their habitats. In the early 1970s, the natural resource agencies that manage seabirds were reorganized and modernized. Congress enacted the Clean Water Act (1972), Fishery and Conservation Management Act (1976), and Oil Pollution Act (1990) which established strong regulatory programs that can protect seabirds at sea. The Endangered Species Act (1973), migratory bird treaties with Japan (1972) and USSR (1976) and various statutes that manage and fund the purchase of public lands can protect seabirds on land and at sea. Despite these advances in law, the natural resource agencies that manage seabirds have not yet achieved the full promise of the new legal protections. Agencies have wide latitude in fashioning programs that are beneficial to seabirds and in determining whether to bring enforcement actions against those who violate the laws. Their agendas are set by officials who must answer to diverse public interests. Conservationists must insure that the protection afforded by law is realized by monitoring the agencies and reminding the public of the importance of seabirds.

Oral Presentation

TERRITORY QUALITY OF BLACK OYSTERCATCHERS IN THE STRAIT OF GEORGIA, BRITISH COLUMBIA.

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Black Oystercatchers (*Haematopus bachmani*) are resident shorebirds of rocky intertidal habitats and defend breeding territories in the Strait of Georgia, B.C. The overall objective of this study is to identify components of territory quality for breeding oystercatchers. A key issue in the Strait of Georgia is the conservation of rocky intertidal habitats, and the ability to predict territory quality independent of bird performance will service in conservation efforts for this area. Three types of evidence will be examined to infer territory quality: [1] permanency of territory occupation, [2] physical characteristics of the breeding territory, such as territory size and [3] prey availability within the territory as a critical resource during the chick rearing period. Given that the bulk of chick provisioning is done within territory boundaries, the amount of resources available is likely the primary determinant of territory quality, responsible for variation in oystercatcher fecundity.

Poster Presentation

TWENTY FIVE YEARS OF OBSERVATIONS BY STUDENTS AT THE OIMB PELAGIC CORMORANT COLONY ON THE CENTRAL OREGON COAST. IS THERE A CORRELATION BETWEEN POSITIVE SEA SURFACE TEMPERATURE ANOMALIES AND BREEDING SUCCESS?

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Undergraduate students at the Oregon Institute of Marine Biology have monitored a nesting colony of Pelagic Cormorants approximately 3km north of Cape Arago (43° $18^{'}$ $45^{''}$ N, 124° $24^{'}$ $5^{''}$ W) from mid June to early August since 1973 with the exception of 1979. Total number of nests, the number of nests with eggs, the number of chicks hatched, and the number of chicks present in early August were correlated with sea surface temperature anomalies from NOAA's Coast Watch advisories and a synthesis of global sea surface temperatures from Allan, Lindesay and Parker (1996). No parameters showed strong correlations with positive anomalies. The lowest hatching and fledging success did occur in years with positive anomalies, but in other years with similar positive anomalies hatching and fledging success were high.

Poster Presentation

FORAGING HABITAT PREFERENCES OF BRANDT'S CORMORANTS OFF THE SANTA CRUZ COAST

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Brandt's Cormorants are important constituents of nearshore waters off California . They likely have significant predatory impacts on subtidal communities, thus making it interesting to know in which particular subtidal habitats they prefer to forage. This study examines the use by foraging cormorants of habitats with these variables: 1) percent cover of kelp-forest canopy and understory/groundcover algae, 2) substrate type, 3) exposure to heavy winds and seas, and 4) proximity to nesting/roosting areas. Brandt's Cormorants were observed foraging in two distinct ways: singly or in close association with other cormorants and/or seabirds. For cormorants foraging singly, habitats with rocky reefs were used significantly more than habitats with sandy bottoms. However, cormorants foraging in groups showed no substrate preferences. Also for solo foraging cormorants, the percent cover of kelp-forests, but not understory/groundcover algae, was positively correlated with usage. The number of cormorants that foraged in groups was unrelated to understory/ groundcover algae as well, but data were insufficient to determine the relationship between group foraging and the percent cover of the kelp-forest. Both group and solo foraging cormorants preferentially used sites that were in close proximity to a colony or roost. Both group and solo foraging cormorants preferentially used sites that were less subject to long-term exposure by heavy winds and seas.

Poster Presentation

STABLE ISOTOPE ANALYSIS REVEALS IMPORTANCE OF INTRODUCED RATS AS PREDATORS OF BURROW-NESTING SEABIRDS ON LANGARA ISLAND, BRITISH COLUMBIA

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On Langara Island, British Columbia, the burrow-nesting Ancient Murrelet (*Synthliboramphus antiquus*) has declined tremendously in recent decades. The Norway Rat (*Rattus norvegicus*) has been implicated as a major factor in this decline. We evaluated the importance of murrelets in the diets of rats using stable-carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and sulfur ($\delta^{34}S$) isotope analysis of muscle and liver tissues of rats and of prey organisms from three regions of Langara Island. Rats were segregated isotopically into three groups corresponding to upland, littoral and seabird nesting areas.. We interpret these groups to represent rats consuming predominantly terrestrial foods, intertidal invertebrates and Ancient Murrelet tissues, respectively. Carbon isotopes segregated marine vs terrestrial diets, whereas nitrogen isotopes were useful in segregating marine invertebrates and seabirds as prey items. Sulfur isotope analysis was not useful likely due to the presence of marine-derived sulphates in the terrestrial foodweb. Our results have important ramifications for dietary investigations of introduced fauna and their impacts on native seabirds on oceanic islands.

Oral Presentation

ANTARCTIC FULMARINE PETREL TROPHIC RELATIONSHIPS: A STABLE ISOTOPE APPROACH

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We employed stable isotope analysis to investigate marine trophic relationships among the Antarctic fulmarine petrel community breeding on Hop Island, Prydz Bay, Antarctica. We measured stable-carbon ((13C) and nitrogen ((15N) isotopes from blood samples from breeding adults and chicks during the 1994-95 (n = 123) and 1995-96 (n = 160) breeding seasons and from representative prey items. (13C was not a useful indicator of trophic position but did indicate that all four species foraged pelagically rather than inshore. In contrast, (15N was a useful indicator and ranged from 3.98 (0.21 o/oo for Antarctic krill to 11.98 (0.64 o/oo for snow petrel chicks. (15N values showed step-wise trophic enrichment. Consistent with known diets, snow petrel chicks showed highest trophic positions. Trophic positions of Antarctic and Cape Petrels and Antarctic Fulmars overlapped extensively. There were no consistent trends suggestive of dietary shifts either within or between breeding seasons. Breeding adults of all four species fed their chicks higher trophic level diets (higher proportions of fish) than they consumed for themselves. Elucidation of seabird community trophic relationships contributes to our understanding of marine ecosystem processes and structure.

Poster Presentation

DIETARY RESPONSES OF TERNS AND SKIMMERS TO SHIFTING PREY ABUNDANCE IN THE SOUTHERN CALIFORNIA BIGHT

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We compared the proportion of northern anchovy to that of Pacific sardine, a warmer water fish, in the diets of three species of tern and skimmer nesting at the Bolsa Chica Ecological Reserve in southern California over a five-year period (1992-1996) based on dropped fish samples. This comparison of the two most common prey species at the Bolsa Chica colony was prompted because of a more than 10-year trend of anchovy decline and sardine increase in the Southern California Bight, perhaps in part as a result of warming temperatures in this ocean environment. We proposed that the Elegant Tern, the most abundant colony member and an almost exclusively ocean forager, would show the strongest response to changing anchovy and sardine abundance despite the claim that it is dependent on anchovy abundance for its reproductive success. This expectation was borne out in that the anchovy-sardine ratio among fish dropped by Elegant Terns at their nests steadily declined from 35:1 in 1992 to 2.6:1 in 1996. Caspian Terns and Black Skimmers shifted less dramatically toward sardines, perhaps because of their broader diets and generally greater use of sardines as prey items.

Oral Presentation

STATUS OF THE MARBLED MURRELET IN THE INNER NORTH COAST RANGES OF NORTHWESTERN CALIFORNIA

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During 1995-96 we surveyed for Marbled Murrelets within 2 late mature/old-growth Douglas-fir habitats. We used the generalized binomial model to determine sample sizes and to estimate the power of survey results for a range of assumed levels of murrelet occurrence (p) and probabilities of detection (p'). No murrelets were detected during 2184 surveys at 273 random sites. When a p of 0.03, and a p' of 0.10 were assumed, the probability that murrelets would have been detected if present was 0.95 and 0.81 for the 2 habitat types. Most habitat characteristics were similar to known murrelet nesting habitat. However, a hotter and dryer climate, relatively high elevation, and low amounts of moss in potential nest trees may have explained the absence of the murrelet. This new information resulted in changes in survey requirements.

Poster Presentation

SEABIRD RESTORATION EDUCATION PROGRAM

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Action Learning is a method of environmental education which provides students with opportunities for active involvement in local environmental projects. The objectives of the Seabird Restoration Education Program are for students to be able to: 1) describe seabirds of the central California coast; 2) describe reasons for seabird decline: egg collecting, gill net fishing, oil spills, and disturbance; 3) describe efforts to restore seabirds, specifically efforts to restore Common Murres to Devil's Slide Rock, and 4) actively participate in the Common Murre Restoration Project. The education program has involved 18 teachers and nearly 1,000 students from San Mateo County coastal schools. Biologists are using social attractants (decoys and amplified murre calls) to restore a breeding colony of Common Murres to Devil's Slide Rock. The associated education program was implemented in September of 1996. Each school year begins with a workshop for teachers; relevant curriculum materials are provided so activities can be taught throughout the school year. After biologists remove the decoys from Devil's Slide Rock, the students actively participate in the restoration project by repainting decoys. When the decoys are redeployed, students keep track of daily high counts of murres, numbers of eggs, and numbers of chicks, using data charts.

Poster Presentation

SATELLITE TELEMETRY OF BLACK-FOOTED ALBATROSSES (*Diomedea nigripes*) DURING THEIR SUMMER DISPERSAL OFF SOUTHERN CALIFORNIA.

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After breeding in the Central Pacific, Black-footed Albatrosses (*Diomedea nigripes*) disperse across the entire North Pacific unrestrained by their duties at the colony. Here I provide the first tracking data for Black-footed Albatrosses and describe the first attempt to track albatross movements during their pelagic dispersal. ARGOS transmitters were attached to three albatrosses on 10-11 July 1997 during an oceanographic cruise off Southern California. Two birds were equipped with transmitters functioning on a continuous duty cycle: albatross #1 was followed for 11 days, during which it traveled 1787 km (430 km straight-line distance from release site), and bird #2 was tracked for 12 days and 1670 km (150 km straight-line distance). Finally, a third albatross equipped with a transmitter operating on a one week duty cycle traveled 5067 km during 35 days. Three conclusions arise from this study: off Southern California, (1) Black-footed Albatrosses are not restricted to foraging ranges in the order of 40-60 nautical miles as hypothesized by Miller (1936, 1940); they range over hundreds to thousands of km, (2) Black-footed Albatrosses do not restrict their movements to the highly productive, cool waters of the California Current as proposed by Miller (1940); they venture into Central Pacific and Transition Zone waters; and (3) analyses at finer scales reveal that albatrosses engage in “traveling” and “searching” behaviors, with “searching” bouts taking place in the vicinity of regions of strong thermal gradients and seamounts.

Poster Presentation

A STUDY OF GENETIC STRUCTURE AND KIN GROUPS IN THICK-BILLED MURRE

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Within a species, populations are likely to show some degree of genetic and phenotypic differentiation. Within a population, further genetic substructuring may occur due to non-random mating, barriers to the exchange of individuals, philopatry with respect to breeding site, or due to the presence of kin groups. Subdivision of a population into kin groups can facilitate the evolution of ‘helping behaviours’ through kin selection. Thick-billed Murres *(Uria lomvia*), arctic colonial cliff-nesters, generally return to breed on their natal ledges. Over a few generations the formation of kin groups may be facilitated. In a previous study at Hornoya, Norway, murres nesting on ledges were found to be related, on average, to the level of first cousins. In other murre colonies phenotypic variation has been reported to occur in clusters. Alloparenting behaviour such as brooding, feeding, or adoption by adults of non-biological chicks has been observed in murres. Alloparenting behaviour, in addition to phylopatry with respect to breeding site, and phenotypic clustering in some colonies raises the question of presence of kin groups within other colonies. Using mitochondrial DNA and microsatellites, a colony of Thick-billed Murres on Coat's Island, NWT, is being examined to obtain information on genetic structuring and kin groups.

Oral Presentation

DIVING BEHAVIOR OF MARBLED MURRELETS: TESTS OF SPECIFIC PREDICTIONS FROM OPTIMAL BREATHING MODELS

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Theoretical models based on central place foraging theory have been constructed to attempt to improve our understanding of diving behavior in air-breathing aquatic animals. I examine key model predictions using diving data collected via radio telemetry from a threatened Alcid, the Marbled Murrelet. Diving data for this species are scarce and little is known about their foraging habits. I measured the duration of dives, surface pauses, diving bouts, diving bout intervals, and percent time underwater during individual dive cycles and dive bouts of telemetered Marbled Murrelets during the 1996 and 1997 breeding season along the central Oregon coast. I observed approximately 6000 dive cycles and 120 complete diving bouts. I found little to no relationship between any diving parameters and water depth. However, significant relationships between many of the diving parameters and year, week within the breeding season, and general location were found. These results suggest these telemetered Marbled Murrelets were likely not benthic foragers and that large to medium scale oceanographic features and events had the greatest influence on their diving behavior during these two summers.

Poster Presentation

SPATIAL DISTRIBUTION OF STELLER'S EIDERS AND POMARINE JAEGERS IN BARROW, ALASKA

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Nesting Steller's Eiders and Pomarine Jaegers were studied at Point Barrow, Alaska in 1995-97. Nests were located on foot surveys and locations were recorded by GPS (Global Positioning System). Measurements were taken between each eider nest and the two closest eider nests, and between each jaeger nest and all eider nests within 300m. All other inter-nest distances were estimated by computing the distance between GPS points. Nests were plotted on digitized maps. A comparison of the area-wide distribution of eider nests with a random distribution (corrected for unsuitable habitat) revealed a clumping of eider nests both within and between seasons. Further, eider nests were non-randomly clustered around the sites of Pomarine Jaeger nests. This distribution is interesting given that Steller's Eiders are not considered colonial, and that the Pomarine Jaeger is a major egg and duckling predator. The observed distribution may play a role in or result from breeding philopatry, kin selection and/or nest defense.

25th Anniversary Symposium Oral Presentation

THE PROGRESS OF SEABIRD BEHAVIOR RESEARCH: 25 YEARS OF INDIFFERENCE TO A SCIENTIFIC REVOLUTION?

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Behavior is fundamental to seabird biology because it determines how individuals search for food, feeding areas, nest sites, and mates, it regulates decisions about reproductive effort that determine life history, and it determines how individuals respond to natural and human-made environmental change and catastrophes. The last 25 years has seen rapid growth of the Behavioral Ecology paradigm, emphasizing an evolutionary approach invoking individual selection. This approach provides the opportunity for crucial insights into seabird ecology. Nevertheless, considerations of behavior has generally been peripheral to Pacific seabird research, which has concentrated on descriptive studies of distribution, population dynamics, physiology and diet. Exceptions to this trend include studies of seabirds' responses to predators, parent-offspring communication, sperm competition, and foraging behavior at sea. Recent improvements in genetic (e.g., DNA fingerprinting), field monitoring (e.g., time-depth gauges, satellite telemetry, pit tags, and radar), and modeling techniques (e.g., GIS and capture-mark-recapture analysis programs such as SURGE and SURPH) provide exciting opportunities if we decide to use them to address the right questions. Solutions to a broad range of theoretical, management and conservation issues in seabird ecology will benefit from a greater emphasis on behavior combining both ecological and evolutionary approaches.

Oral Presentation

MARBLED MURRELETS, THREE NESTINGS, CHICK AND ADULT BEHAVIOURS COMPARED

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One hundred and four Marbled Murrelet chick feedings were observed by the author and a small group of researchers representing Friends of Caren at two separate nest sites and three nestings during 1993, 1994 and 1997. All nestings took place on the Caren Range of British Columbia's Sunshine Coast. A summary has been prepared which documents feeding times related to sunrise and sunset, duration of feedings, frequency of visits by both adults, variations in arrival and leaving behaviours of adults and kinds of fish fed to the chick. Vocalisations of adults and chicks at the nest were noted and some of these were recorded using directional and parabola microphones. The total number of volunteer hours spent in recording breeding information was 73.5, 36.5 and 101.5 hours in 1993, 1994 and 1997 respectively. In those same years a total of 94 feedings were timed, with 40, 14 and 40 feedings respectively. Total feeding durations in the same years were 531, 166 and 560 minutes respectively. The 1993 successful nesting was from 7-20 August, while both 1994 and 1997 nestlings fledged on 3 and 1 July, respectively. Fledging behaviour is described.

Oral Presentation

KRILL VS. FISH: POTENTIAL FOR PREY-SWITCHING AMONG *PYGOSCELID* PENGUINS IN A RAPIDLY CHANGING ENVIRONMENT.

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Three species of penguins breed on King George Island, Antarctica, the Gentoo, Adelie and Chinstrap penguin. Krill is a major component of the diet of each species, however, they also consume fish. We analyzed the composition and percentage of fish taken by each of the three species of penguin. Diet samples were obtained by lavaging five breeding adults of each species every week during chick rearing period for five consecutive austral summers. These data indicate major differences in diets among the penguin species. Krill populations have been negatively affected in the past decades due to a decrease in heavy winter ice on which they depend for survival of young individuals. In addition, an active krill fishery has developed adjacent to the breeding colony. If krill becomes limited as a result of climate change and/or expanding commercial fisheries, the penguins may come to rely more on secondary prey items. Changes in the percentage of, or shift in species assemblages of fish eaten, could reflect variations in environmental conditions and/or impacts caused by human commercial activities. Results of this study point to the importance of paying closer attention to prey items heretofore considered incidental.

Oral Presentation

BIOLOGY AND CONSERVATION OF THE BLACK-VENTED SHEARWATER

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Little has been published on the biology of the Black-vented Shearwater. It breeds on only three island groups in northwest Mexico: Natividad, San Benitos, and Guadulupe. All three island groups have permanent human inhabitants and introduced mammals, both of which are known to negatively effect seabirds. Data on the breeding biology and natural history of the Black-vented Shearwater and the impacts of humans and introduced mammals are essential for informed management of this Baja California endemic. In 1997 I spent four months on Isla Natividad which supports perhaps 90 percent of the world's population, studying the natural history of the Black-vented Shearwater. The colony covers 2.5 km^2 and most suitable habitat is occupied by burrows. I estimated the number of burrows on the island to be 114,455 $\pm$ 27,520. Burrow occupancy was 66.9% (n=171). The estimated number of breeding pairs is 76,570 $\pm$ 18,411. Birds appear to attend the colony year round. Laying begins in March, hatching occurs in May and fledging occurs about 70 days after hatch (range 62 to 72 days, n=4). The main threats to Black-vented Shearwaters on isla Natividad are introduced cats, the building of new roads, and the disposal of garbage in the colony.

Poster Presentation

WATERBIRD INJURY DETERMINATION AND RESTORATION IN CALIFORNIA, 1986-1997

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With the advent of the federal Oil Pollution Act of 1990 and the California Oil Spill Prevention and Response Act of 1990, new regulatory provisions for natural resource damage assessment and restoration were mandated. Beginning in 1986 the trustee agencies for seabird resources in California conducted increasingly focused wildlife injury determinations. The U.S. Coast Guard Area Contingency Plans for California direct the trustees to collect time sensitive data which can be used to quantify wildlife injuries. These activities are described. Eight damage assessments, (one currently in progress) are profiled and waterbird restoration strategies in seven cases are reviewed.

Oral Presentation

MARINE BIRD ABUNDANCE IN PRINCE WILLIAM SOUND, ALASKA: TRENDS FOLLOWING THE *T/V EXXON VALDEZ* OIL SPILL.

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It was found that several marine bird species were injured by *T/V Exxon Valdez* oil spill. This study was initiated to monitor recovery of these injured species. We conducted surveys of Prince William Sound during March and July between 1989 and 1996. We then estimated and compared the populations of marine birds in oiled and unoiled zones. During March, cormorant, goldeneye, scaup, Bald Eagle, and Herring Gull populations showed significant differences between the zones. All results, except scaup, were consistent with an oil spill effect. During July, scoters, jaegers, Black-legged Kittiwakes, gulls, Kittlitz's Murrelets, Horned Puffins, and all puffins showed significant differences in the two zones. Scoters, jaegers, kittiwakes, and gulls had results consistent with an oil spill effect. The results for the other species showed possible recovery. Although these data indicate that some species are exhibiting recovery, most are not. Thus, recovery of many marine bird species from a large perturbation, such as the *T/V Exxon Valdez* oil spill, is not statistically detectable with data from five surveys.

Poster Presentation

BARREN ISLANDS SEABIRD STUDIES

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As part of the five-year-long Alaska Predator Ecosystem Experiment (APEX, a project sponsored by the *Exxon Valdez* Oil Spill Trustee Council consisting of 16 seabird and forage fish studies in Prince William Sound and lower Cook Inlet), we collected data on several breeding and foraging parameters of Common Murres, Black-legged Kittiwakes, and Tufted Puffins at the Barren Islands since 1995. Breeding parameters included nesting chronology, productivity, and chick growth rate; foraging parameters included adult nest attendance and foraging trip duration, and chick feeding frequency and meal size. The three seabird species were chosen for study because they have different foraging strategies. By comparing information from these species within and among years and among other colonies, we hope to increase understanding of how seabirds respond to changes in food availability and quality. We also monitored the prey base by collecting data on chick and adult diets and by beach seining near the colonies. Another APEX research unit conducted hydroacoustic and trawl surveys to obtain additional information on the food web. Some preliminary comparisons from our 1995-1997 data are presented in this poster.

Oral Presentation

WITHIN-COLONY VARIABILITY IN KITTIWAKE PRODUCTIVITY

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Food availability during the breeding season is generally considered the most important factor regulating the productivity of seabirds. Paradoxically, spatial heterogeneity in reproductive performance is a common feature of seabird breeding colonies despite the fact that all individuals potentially have access to the same food resources. I studied within-colony variability in the productivity of Red-legged Kittiwakes and Black-legged Kittiwakes on St. George Island by monitoring the fate of nests on 273 photographic plots. For each year of the study (1993-95), I found greater among-plot variability in productivity than could be attributed to chance: nests within plots tended to experience a common reproductive fate. Although my analyses identified several factors that may have contributed to spatial heterogeneity in kittiwake reproduction (nest density, elevation, plot size, species composition, plot aspect), these factors only partially account for variability among plots. I restricted my analyses to plots that shared common attributes for the above factors and still found significant variability among plots. Reproductive variability cannot be explained by localized predation or differences in bird quality between plots. Therefore, I tentatively propose that social facilitation may be responsible for spatial heterogeneity in kittiwake productivity on St. George Island.

REPRODUCTIVE EFFORT IN CASSIN'S AUKLETS: ARE OLDER MOTHERS MODULATING EGG VOLUME BASED ON BODY CONDITION?

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In pelagic seabirds, body reserves are maintained to allow for foraging trips between feeding grounds and the breeding colony. In long-lived species which produce few young in a lifetime, age and body condition are probable factors in determining what reproductive strategy an individual employs. Cassin's Auklet reproductive effort based on egg size was studied on Triangle Island, British Columbia in 1996. Eye colour was utilized to divide breeding individuals into two age classes. Mass corrected for structural size was used as a measure of adult body condition. A molecular sexing technique was employed to sex breeding pairs and chicks. Egg size and maternal body condition were positively correlated in old mothers, but not in young mothers. This result implies that old mothers are modulating their egg size based on body condition, suggesting a possible mechanism for age-specific reproductive success. In alcids, male parental care is essential for reproductive success; consequently a father's body condition might be expected to influence egg size. Males can only affect egg volume through the influence they have on the female, possibly by defending the burrow from other potential breeding Cassin's Auklets.

SEABIRD MANAGEMENT ON LAND: PAST PRACTICES AND FUTURE TRENDS IN THE CONSERVATION OF SEABIRD NESTING HABITATS

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Seabirds and their nesting habitats have traditionally been protected by legislation and establishment of nesting sanctuaries. At sanctuaries, management usually consists of habitat acquisition by conservation agencies and non-profits, posting and enforcement of wildlife laws by wardens. While habitat protection - especially of large, productive colonies - must remain the backbone of seabird protection on land, this largely passive approach does not necessarily lead to restoration of historic breeding sites, range expansion, increased diversity, protection from introduced or native predators or public education. Increasing human populations and intensive land use along our coasts are putting severe pressure on many seabird populations. These pressures often favor adaptive species such as Western Gulls and Double-crested Cormorants, while specialists such as Roseate Terns and Marbled Murrelets become threatened and endangered. More proactive techniques for seabird conservation are necessary to protect the diversity of Pacific seabirds. This paper presents case studies demonstrating the value of proactive techniques for seabird protection and restoration, including predator control, reserve design, social attraction, translocation and public education of special interest groups.

Poster Presentation

MARBLED MURRELET PRODUCTIVITY RELATIVE TO FORAGE FISH ABUNDANCE AND SPECIES COMPOSITION

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We present evidence that forage fish abundance is correlated with Marbled Murrelet productivity. We also suggest a possible link between diet and murrelet chronology and productivity. We conducted at-sea surveys to index murrelet productivity in Prince William Sound, Alaska, in 1995 (4 sites), 1996 (1 site), and 1997 (3 sites). At each site we repeatedly surveyed waters 0-200 m offshore in June, July and August. The APEX forage fish study surveyed fish abundance at these sites with hydroacoustics in July and August of each year. In both 1995 and 1997, average nearshore fish biomass was positively and significantly correlated with average juvenile murrelet density at the sites. At the site with 3 years of data (Naked Island), juvenile murrelet density paralleled annual changes in nearshore fish biomass. In 1997 we identified fish species held by adult murrelets prior to delivery to chicks. At one site where >80% of the chick diet was Pacific sand lance, fledging began and peaked earlier, and fledgling densities were higher, than at a site where >80% of the murrelet diet was Pacific herring.

Oral Presentation

GENETIC DIFFERENTIATION OF HARLEQUIN DUCK POPULATIONS WITHIN AND BETWEEN THE ATLANTIC AND PACIFIC COASTS OF NORTH AMERICA

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The possible listing of Harlequin Ducks on the Atlantic Coast and concerns regarding recovery of the species in Prince William Sound, Alaska (subsequent to the *Exxon Valdez* Oil Spill), have raised questions about the extent of population differentiation and movement across the species' geographic range. Due to lack of observational evidence of movements among regions, we used genetic markers which differ in mode of inheritance and rate of evolution to evaluate the degree of genetic differentiation among geographically separate populations within and between the Pacific and Atlantic Coasts. Analyses of microsatellite loci indicate allele frequencies are quite similar among populations within the Pacific (Alaska to Oregon) and Atlantic Rims (Iceland to Nova Scotia). Similarly, Pacific and Atlantic Rim populations had similar allele frequencies, suggesting that either the species as a whole has undergone little genetic change since glaciation or gene flow is still occurring over broad geographic areas. On-going mitochondrial DNA analyses will reveal the extent of female-mediated gene flow and degree of phylogeographic structuring within and between the two regions.

Oral Presentation

SCALE-DEPENDENT SPATIAL VARIANCE PATTERNS AND CORRELATIONS OF SEABIRDS AND PREY IN THE SOUTHEASTERN BERING SEA AS REVEALED BY SPECTRAL ANALYSIS

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Uni- and bivariate spectral analyses of the spatial distribution of Thick-billed Murres and acoustic estimates of prey biomass in the southeastern Bering Sea were used to examine the spatial variance patterns of a predator and its prey at multiple spatial scales. Power, phase and coherency spectra from individual transects, as well as those averaged over all transects, were examined. The average spectra, representing a temporal scale of months, showed that murres and prey had similar spatial variance patterns and were positively correlated over the range of spatial scales studied. The individual spectra, representing a temporal scale of hours, showed several patterns that were not evident in the average spectra. In particular, the transect-level analyses showed that the correlation between murres and prey was poor at spatial scales where prey variance was relatively low. This result suggests a new hypothesis to explain poor small-scale correlations between consumers and resources: resource distribution is relatively uniform at small scales resulting in only a slight increase in foraging return for consumers showing an aggregative response at these scales. The differences among spatial scales and between the average and individual spectra illustrate how ecological patterns can vary with temporal and spatial scale.

Poster Presentation

MONITORING MARBLED MURRELETS WITH RADAR IN DESOLATION SOUND, BRITISH COLUMBIA

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I monitored the annual flight of Marbled Murrelets through Theodosia Inlet (a narrow fjord off Desolation Sound, British Columbia) with radar during the breeding seasons of 1996 and 1997. At the same time, human observers counted birds using standard audio/visual detection methods. I compared daily and seasonal numbers of birds between 1996 and 1997, and calculated the inter-annual coefficient of variation (necessary for calculation of power) and generated power curves for both human and radar monitoring. In addition, I used the information from radar monitoring to augment our group's demographic study.

Oral Presentation

DEMOGRAPHY OF MARBLED MURRELETS IN DESOLATION SOUND, BRITISH COLUMBIA

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Since 1991 our group has banded 774 adult Marbled Murrelets in Desolation Sound. Murrelets can be reliably captured using mist nets on floating rafts. In 1997, we captured 172 new adults and recaptured 39 birds banded previously with mist nets, allowing us to estimate survival and population size. We recaptured a bird banded in 1991, extending the longevity record for murrelets to 8+ years. In addition, the dip net technique resulted in 109 new captures, 8 recaptures from previous years and 28 juveniles. The juveniles are our first sample of known age birds. We marked 69 adults and 15 juveniles with combinations of wing tags, radio transmitters and nasal disks. To investigate murrelet movements, distribution and use of the marine environment, We conducted regular marine surveys throughout the breeding season, using both marked and unmarked birds. We found both diel and seasonal shifts in habitat use. In September 1996, a bird which we had banded in 1995 was recaptured in northern Washington by American researchers. We recaptured the same individual this year, providing the first evidence of seasonal movement. Our results suggest that the marine habitat must be considered for effective conservation measures.

Poster Presentation

COMPARISON OF SURVEY METHODS FOR ASSESSING CORVID ABUNDANCE IN MARBLED MURRELET NESTING STANDS

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We conducted an artificial nest study on the Olympic Peninsula of Washington (1995 to 1997) and in the Coast Range of Oregon (1997) to assess the influences of stand and landscape level variables on the risk of nest predation to Marbled Murrelets. Concurrent with our artificial nest experiments, we conducted surveys of corvid abundance in our nest stands to examine a possible correlation between corvid abundance and nest predation rates. We censused corvids using a variety of techniques including point count surveys, transect surveys, and the broadcast of corvid territorial and predator attraction calls (to maximize probability of detection). We found point count values had the strongest correlation with artificial nest predation. We suggest using the maximum value for each corvid species attained from several point count surveys in each stand. Use of attraction calls may over-represent corvids at the stand level but is important in assessing the landscape-level presence of wide-ranging (ravens) and often non-vocal (Gray Jays) corvid nest predators.

Oral Presentation

STATUS AND TREND OF THE SAGUAGAHGA RED-FOOTED BOOBY COLONY ON THE ISLAND OF ROTA, COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS

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A large breeding colony of Red-footed Boobies occurs in the Saguagahga region on the island of Rota, Commonwealth of the Northern Mariana Islands, USA. The colony lies in limestone forest along the southeastern coastline beneath 100 meter high cliffs and along a 200 to 500 meter wide plateau. Complete counts of birds, eggs, and nests have been recorded at least quarterly since 1992. Breeding occurs circannually, with as many as 700 nesting pairs active during the peak season between November and January. Population numbers appear stable, in spite of significant threats facing the colony, including development abutting the cliffline above the colony, poaching, and introduced predators. An overlook, which provides tourists an opportunity to observe nesting birds while minimizing disturbance, was constructed in 1991 over the southern portion of the colony. The Saguagahga region was established as a sanctuary in 1994 because it protects a wide variety of native plants, seabirds, and fruit bats, and represents a valuable ecotourism resource.

Oral Presentation

POPULATION TRENDS OF THE COMMON MURRE IN CALIFORNIA, OREGON AND WASHINGTON, 1979-1995.

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Aerial surveys of breeding sites of Common Murres were conducted from 1979 to 1995 in California (Central and Northern), Oregon and Washington. Survey continuity varied among the four areas. Trend analyses were based on annual whole-colony counts. A correction factor of 1.67 was used to estimate total numbers of birds using colony-sites. In central California, murres declined from 1980-1995, with steep decline occurring in 1982-89 and limited increase in more recent years. Trend analysis in northern California is more difficult due to less continuous colony data but the population appears to be stable. Oregon murre trends, based on 1988-95 data at 15 colony-sites, showed slow population decline. Washington has experienced a significant population decline and colonies show substantial annual variation in attendance. The most dramatic decline was along the southern Washington coast. The total number of individual murres attending colonies in California, Oregon and Washington was about 1.2 million; most birds now breed in Oregon and northern California.

Poster Presentation

MARBLED MURRELET HABITAT ASSESSMENT: TECHNIQUES TO MEASURE CANOPY DENSITY

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Canopy density is one variable measured when assessing Marbled Murrelet (*Brachyramphus marmoratus)* nesting habitat. Openings in the canopy facilitate travel through a stand by the murrelet, and may be important for access to nest sites. Three methods of measuring canopy density within a stand are compared for accuracy: 1) use of a densiometer; 2) measurement of gap openings using a 50 metre measuring tape, and 3) analysis of overstory photographs. Repeatability of individual gap measurements is examined to determine the validity of using this technique by different crew members. These results on the accuracy and precision of canopy density measurements can be used by researchers to chose the most appropriate method for Marbled Murrelet habitat studies. Estimations of cost and time required will also be considered in the suitability of these methods.

Oral Presentation

HABITAT CORRELATES OF MARBLED MURRELET NEST PREDATORS: STAND VERSUS LANDSCAPE ATTRIBUTES

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We investigated the relative abundance of Marbled Murrelet nest predators (jays, crows, ravens, and squirrels) from 1995 to 1997 on Washington's Olympic Peninsula and in 1997 on Oregon's central coast. Predators were surveyed using modified point counts (some longer observations and attractant calls were employed) in forested stands ranging in size from 30-110 ha. Each predator's abundance was influenced by unique habitat requirements, but stand-level attributes (structure, composition, and physical features) were typically less strongly correlated with abundance than were landscape-level attributes (proximity to human activity, % mature forest within 5 km of the stand, and landscape fragmentation). The amount and type of stand edge was also important. In general most predators were most abundant near human activity, in fragmented habitats, and in late successional forest. Managers and planners can increase their effectiveness at identifying and conserving murrelet nest areas by considering attributes of the landscape in addition to attributes of the nest stand.

Oral Presentation

THE POTENTIAL EFFECTS OF ENVIRONMENTAL, OBSERVER AND SITE DIFFERENCES ON INLAND DETECTION LEVELS OF MARBLED MURRELETS.

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Many agencies and others are interested in evaluating impacts of forest harvest or manipulation in potential Marbled Murrelet nesting habitat. A primary tool for this evaluation is observations from surveys conducted at inland forest sites. As part of an effort to evaluate the current survey design, we examined the relative effects of spatial, temporal, and environmental variables (e.g. cloud cover and moon phase) on detection levels at several sites in northern California. Multiple linear regression analyses indicated that most of the variance in counts was a result of day-of-year and location, and to a much lesser extent with cloud cover. We compared high, moderate, and low detection sites and found no significant differences among sites in the patterns of relative detection levels through the year. These results indicate that data collected at a single site in different years and under different weather conditions can be pooled. It is important, however, in comparing detection levels between sites, that we first adjust for within-season differences.

Oral Presentation

THE PRIMITIVE STATE OF SEABIRD BYCATCH MANAGEMENT IN WORLD INSHORE GILLNET FISHERIES

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We reviewed available literature (97 papers) on seabird bycatch in inshore gillnet fisheries from 15 countries including two regions in Canada and four US states. Our objective was to determine the global scope of inshore gillnet bycatch including: seabird species caught, methods of investigation, extent of population level impacts, and the nature and effectiveness of fisheries management actions to reduce bycatch in these fisheries. Deep diving alcid species are most commonly entangled, especially Common and Thick-billed Murres and Razorbills and in some areas (North Sea) diving ducks are the primary species caught. At least eight techniques were used to evaluate bycatch ranging from anecdotal reports and fisher interviews to vessel or land based observer programs; few yielded bycatch rates or reliable population level impact assessments. From the papers reviewed we found that only in the US, in California and Washington, were direct management actions taken to reduce seabird bycatch, suggesting that in most countries of the world seabird bycatch management in inshore gillnet fisheries is at best in a primitive stage of development and rarely a resource management priority.

Oral Presentation

DIE-OFF OF SHORT-TAILED SHEARWATERS AND OTHER SEABIRDS IN WESTERN ALASKA, SUMMER 1997

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In August 1997, dead and dying Short-tailed Shearwaters were reported in unusual numbers on beaches and nearshore waters of Alaska, from the Alaska Peninsula to northeastern Russia and the Chukchi Sea. Frequencies of dead shearwaters on beaches were 5-50km-1 on the Alaska Peninsula and 15-350km-1 in the Bering Sea. Other species were affected in more limited area: Black-legged Kittiwakes along the Alaska Peninsula, and murres and possibly other diving species in parts of the Bering Sea. Dead shearwaters were much lighter in weight than live birds in good condition. Necropsied birds were emaciated, and parasitic but not microbial disease was present; death probably was due to starvation. Shearwaters died off over a similar area as during the El Niño year of 1983; other species were affected differently in the past. Sea surface temperatures were the highest recorded in Alaska. If this oceanographic anomaly intensifies next year, as expected, impacts on seabird populations may be observed.

Oral Presentation

MARBLED MURRELETS, WHERE ARE THEY AND WHO ARE THEY WITH: DISTRIBUTION AND COMMUNITY RELATIONSHIPS OF THE MARBLED MURRELET IN THE NORTHERN PUGET SOUND AND HOOD CANAL, FALL AND WINTER 1995 - 1996.

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We conducted marine seabird surveys in northern Puget Sound and Hood Canal in Northwest Washington from August - November in 1995 and 1996. We studied community relationships of the Marbled Murrelet (*Brachyramphus marmoratus*). Murrelets are associated with Pigeon Guillemots (*Cepphus columba*). Some data suggest negative associations with Western Grebes (*Aechmophorus occidentalis*). Murrelets are typically found at distances of 250 - 350 meters off shore. For both years higher densities of murrelets were found in protected inlets and bays later in the season. The areas where murrelets associate with guillemots are believed to be areas with high prey densities. The birds do not form mixed foraging flocks rather they are linearly distributed over several kilometers. Sheltered waters offer protection for the birds in seasonally inclimate weather.

Poster Presentation

MARBLED MURRELET USE OF LANDSCAPES FOR NESTING IN SOUTHERN OREGON.

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I evaluated the effect of fragmentation of old-growth forest stands in southwestern Oregon on use of these stands by nesting Marbled Murrelets (*Brachyramphus marmoratus*). Fragmentation indices were calculated on successional forest vegetation patches within 203 ha circular areas around occupied and unoccupied sites. Sites occupied by marbled murrelets had more interior habitat within old-growth patches and greater patch diversity than unoccupied sites. Total edge and patch shape were not important. Increased access of predators to nest sites is believed to be the major cause of the lower use of the fragmented habitats.

Oral Presentation

TREND ANALYSES OF MARBLED MURRELET POPULATIONS IN NORTHERN CALIFORNIA

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Monitoring for the Marbled Murrelet is best accomplished through at-sea censuses. We have estimated the size and trends of populations in northern California from more than nine years of data, using two types of line transects: (1) intensive surveys, designed to identify the abundance distribution of the birds from shore out to 6000 m, and (2) extensive surveys positioned at two distances from shore within the peak of abundance and paralleling the shoreline from Oregon to central California. We will describe the use and power analyses of the variable distance method which has been used for the entire study. Annual density estimates have shown high variability, but trends, generally, have been stable or downward in the various sections of the coast.

Poster Presentation

PREY FISH SAMPLING BY FORAGING COMMON TERNS: A COMPARISON TO HUMAN TRAWL SAMPLING

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Hamilton Harbour (Lake Ontario) was designated in 1993 for study by the national Ecosystem Rehabilitation Program. As one part of that program, DJM and RDM used radiotelemetry to identify the primary foraging areas used by Common Terns. We assumed that prey fish delivered by terns to their chicks might be indicative of bait fish species diversity and abundance, but required a comparison with standard fisheries techniques. Accordingly, we collaborated with SKS during a one-week period in June 1995 to compare measures of relative fish diversity/abundance determined by (a) fish returned by foraging terns and (b) trawl sampling at locations where terns were known to forage. The two methods yielded different patterns of species composition and relative abundance of fish. Emerald Shiner was the predominant species identified by both methods. However, trawl sampling captured only two species (Emerald Shiner and Alewife) while terns delivered six species to chicks. Trawl-sampled fish were also larger on average than those delivered by terns. We conclude that both sampling methods contain biases but together provide a general view of fish populations in the area.

Oral Presentation

"COURTSHIP" FEEDING IN COMMON TERNS: ITS NUTRITIONAL FUNCTION AND EFFECTS ON EGG SIZE.

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To quantify the nutritional importance of "courtship" feeding during clutch formation we (1) estimated the lipid and energy requirements of individual females, and (2) and compared these costs to the amount of food provided by their mates. Our data support a nutritional hypothesis for mate-provisioning: (1) the temporal pattern of food delivery by males matched the pattern of female energy requirement, and (2) based on our estimates of clutch production costs, the average male provided 40% to >100% (depending on time relative to laying) of his mate's daily nutritional requirement. However, there was considerable variation in provisioning rates among males. Does this variability in provisioning effort by males reflect variation in the size of eggs produced by females? Provisioning rate during the interval between first and second eggs was the only variable to explain a significant amount of variation in egg size. Contrary to expectation, females provisioned at higher rates produced clutches with lower total volumes, relatively smaller C-eggs, and took longer to complete their clutches than those females provisioned at lower rates. Could this observation represent an adaptive strategy employed by females?

Oral Presentation

DESIGNING STUDIES TO EXAMINE THE EFFECTS OF HUMAN DISTURBANCE ON NESTING MARBLED MURRELETS AND SUMMARY OF PRELIMINARY RESULTS

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A pilot study was initiated in Oregon and Washington in 1997 to test the effects of human disturbance on nesting Marbled Murrelets. To successfully test for the effects of disturbance on this secretive seabird: 1) active nests were monitored with an 8 mm infrared real-time video camera installed so that views of both the chick on the nest and adults perched on adjacent landing pads were obtained to record the behavioral response of both chick and adults; 2) cameras were installed within 1 meter of the nest to detect and record detailed behavioral changes as disturbances occurred and; 3) infrared capability allowed the recording of behaviors 24 hours, and during crepuscular periods, when adults and chick were most active. By matching the time of local disturbance recorded by ground observers with the video recordings at the nest, behavioral responses to disturbances could be recorded. Preliminary results indicate that adults are more effected by a variety of disturbances than chicks. Some human disturbances resulted in aborted feeding visits after adults were flushed from the nest limb or adults were prevented from making a feeding visit. Adults may respond differently to disturbances among sites due to acclimation to local background disturbances.

Oral Presentation

SURVIVAL IN CASSIN'S AUKLETS ON SOUTHEAST FARALLON ISLAND: TEMPORAL PATTERNS, POPULATION VIABILITY, AND THE COST OF DOUBLE-BROODING.

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Adult survival was estimated for Cassin's Auklets (*Ptychoramphus aleuticus*), using capture/recapture analyses of birds breeding in nestboxes on Southeast Farallon Island, California. Preliminary results indicate annual survival of c. 70% (S.E.=2%), with no sex difference in survival or recapture probability. Annual survival was similar across years except for 1982/83 and 1992/3 when survival was c. 50%. Average survival is very low compared to other studies of alcids, and substantially lower than what Gaston reported for a British Columbia population. These findings are consistent with the observation that Cassin's Auklets in CA (but not BC) are commonly double-brooded. We present a population dynamic model which demonstrates that low adult survival of this population may account for the large drop in population size over the past 25 years, a drop of over 65%. In addition, we examine age-specific survival patterns and whether individuals that double-brood are more likely to survive (indicating differences in phenotypic quality) or less likely (indicating a cost of reproduction overriding any differences in quality).

Plenary Presentation

FIFTEEN MILLION YEARS OF CHANGE IN THE MARINE ENVIRONMENT AND WHAT IT HAS MEANT FOR NORTHERN SEABIRDS.

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Extensive collections of fossil seabirds from the western North Atlantic document dramatic changes in seabird faunas of the northern oceans in the past 15 million years. Fourteen million years ago, the waters of mid-Atlantic region were warm temperate to subtropical with relatively few seabirds. This changed radically by 5 million years ago when presumed upwelling created a phenomenally rich marine environment with dozens of species of pelagic birds, including many that are now confined to the Pacific. There were five species of albatrosses, for example, including the three existing North Pacific species. A breeding colony of Short-tailed Albatrosses existed on Bermuda until about 450,000 years ago. Many extinctions took place in the North Atlantic, particularly of auks. Patterns of distribution were also very different, for example, there are absolutely no murres or guillemots in the North Atlantic during the Tertiary, the earliest yet known being a Pleistocene murre about 12,000 years old. The nature and possible causes of extinctions and changes in distribution will be discussed.

Oral Presentation

ASSESSMENT OF AVIAN MORTALITY RESULTING FROM THE NAKHODKA OIL SPILL IN JAPAN

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On 2 January 1997, the Russian tanker Nakhodka spilled more than 6000 kl of C-grade fuel oil in the Sea of Japan. Beached birds were first discovered on 8 January, and continued to wash up on the shores of nine prefectures for several weeks. 1311 birds, including at least five Long-billed Murrelets and three Japanese Murrelets, were collected for rehabilitation or as carcasses. In the past, Japanese efforts for protecting birds from the impacts of oil spills have been limited to rehabilitation of beached individuals. This time, with the help of American biologists, we tried to estimate total avian mortality. We formed OBIC (the Oiled Bird Information Committee), composed of six environmental and scientific NGOs, to collect and compile critical data and help co-ordinate local volunteer efforts. We report on the spill and on the progress of the assessment effort.

Poster Presentation

SEABIRD ABUNDANCE AND BLACK-LEGGED KITTIWAKE PRODUCTIVITY RELATIVE TO FORAGE FISH BIOMASS IN PRINCE WILLIAM SOUND, ALASKA

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We sought to determine if there was a relationship between seabird abundance and indexes of Black-legged Kittiwake (*Rissa tridactyla*) productivity relative to forage fish biomass. Working with the University of Alaska, Fairbanks, School of Fisheries and Ocean Sciences we simultaneously collected hydroacoustic data on forage fish and seabird locations in three study areas of Prince William Sound, Alaska. During July - August 1995 and 1996 we sampled on pelagic transects. In 1996 we added nearshore survey blocks within our major study areas to improve our sampling of habitats associated with the greatest seabird activity. Kittiwake productivity data were collected at colonies located within the three study areas. Seabird/forage fish comparisons were made graphically at a course scale (study areas as the sample unit). We made finer scale (nearshore study blocks as the sample units) comparisons of seabird abundance and fish biomass using linear regression. At our course scale forage fish biomass near shore corresponded to kittiwake numbers observed during surveys and the number of chicks at colonies. At our finer scale, fish biomass alone did not predict seabird numbers; however, through multiple regression we determined seabird abundance was negatively related to the contour gradient of the ocean floor and positively related to fish biomass (piscivorous bird numbers = 9.3 - 127 bottom gradient + 0.14 fish biomass, $P = 0.029$ $r = 0.56$).

Oral Presentation

SUBTLE SIGNS OF EL NIÑO: THRESHOLDS AND SETPOINTS IN SEABIRD SURVIVAL

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The 1997 El Niño event took the oceanographic world by surprise. None of the climate models accurately predicted the intensity of water warming or the rapidity of temperature change. By June, water temperatures throughout the Pacific Basin were 5-8°C above average. Plankton distribution and abundance anomalies were reported throughout the Pacific Northwest, including a massive cocco-lithophore bloom in the Bering Sea. Range extensions both north and south were reported for many species of mid and upper trophic level fishes. Was such a strong “bottom-up” signal detectable in the seabird community? Attendance, productivity, and foraging activity data for Common Murres (*Uria aalge*) in Washington State, indicate that murres, although certainly susceptible to the bottom-up regulation, did not appear to respond negatively. The reasons for the lack of response include: temporal and spatial buffering, behavioral accommodation, and location, location, location.

25th Anniversary Symposium Oral Presentation

DISTANT WATERS: MANAGING FISHERIES AND SEABIRDS INTO THE 21ST CENTURY

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By the 1970's, many world stocks of forage fish had collapsed from over-fishing. Stock depletions were accompanied by significant declines in seabird populations and productivity (e.g., in Norway, South Africa, Peru), and gill-net mortality decimated some seabird populations (e.g., in Greenland, California). Consequently, many studies conducted during the past 25 years have focused on trophic relations of seabirds and mortality in fishing operations. Estimating net-mortality has been a relatively simple exercise in sampling and statistics; eliminating bycatch remains a socioeconomic and political issue. In contrast, seabird predator-prey interactions are complex and still poorly understood. Models evolved to assess trophic relationships: Energy- and time-budgets were measured, temporal and spatial scaling was applied, and multi-species interactions were evaluated. Models suggest that seabirds consume 10-30% of fish production near colonies, but management implications remain unclear. Recent studies involving concurrent measures of seabird population parameters and local prey dynamics suggest that seabird survival and productivity are not simple functions of prey abundance: Stochastic events (e.g., El Niño), regime shifts, behavioral buffers against prey fluctuations, non-linear predator-prey dynamics, and the over-riding influence of marine climate cycles, all befuddle our attempts to ‘manage’ seabirds and fisheries - and set our course of study into the 21st century.

Poster Presentation

COOK INLET SEABIRD AND FORAGE FISH STUDIES (CISEAFFS)

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Populations, productivity, diets and foraging behavior of 6 seabird species (murre, kittiwake, guillemot, puffin, cormorant, gull) were studied during 1995-1997 at 3 seabird colonies in lower Cook Inlet (Chisik, Gull and Barren islands). Oceanographic measurements, seabird and hydroacoustic surveys, trawls, and beach seines were conducted in waters around (<40 km) each colony. Offshore and southern waters of Cook Inlet were dominated by juvenile walleye pollock and capelin, important prey for murres and puffins. Nearshore waters of Cook Inlet were dominated by sand lance, which were consumed by seabirds (e.g., kittiwakes, guillemots, murres) in proportion to their local abundance. Forage fish densities ranged from 10's fish/m^3 (pollock) to 100's and 1000's of fish/m^3 (sand lance). Acoustically-measured forage fish biomass was lowest around Chisik Island, moderate in Kachemak Bay, and highest around the Barren Islands. Correspondingly, seabird densities at sea and seabird breeding success ranged from relatively low in the Chisik Island area to relatively high in the Barren Islands area. Populations of seabirds at Chisik Island continued a long-term decline, whereas populations at Gull and Barren islands are stable or increasing. Behavioral studies revealed that seabirds worked harder (longer foraging trips, less “free” time) at colonies where nearby fish densities were lower.

Oral Presentation

GEOGRAPHIC VARIATION AND REASSESSMENT OF SPECIES LIMITS IN THE "MASKED" BOOBIES OF THE EASTERN PACIFIC OCEAN

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Two distinct forms of Masked Booby (*Sula dactylatra*) occur in the eastern Pacific: (1) a yellow-billed form that includes a population on Clipperton Island and islands off western Mexico (*S. d. "californica"*), and another, unnamed, population on Las Islas Desventuradas, Chile, and (2) an orange-billed form (*S.* [*d.*] *granti*) that nests almost exclusively on the islands of the Galápagos and on Malpelo Island, Colombia. Quantitative comparisons, including Principal Components Analysis (PCA) of standard morphological characters indicated that yellow-billed populations are only marginally different from one another, and neither is consistently separable from *S. d. personata*, a yellow-billed form which ranges over most of the tropical Pacific. Further, we found no consistent differences in bare-part coloration or plumage among yellow-billed populations. In contrast, PCA clearly separated orange- from yellow-billed birds. The orange-billed bird is smaller with a significantly shorter, shallower bill, shorter tarsus, and longer wings and tail. It is also more sexually dimorphic and has distinct plumage characters. Biological observations also support the distinctness of orange-billed birds. They typically nest on cliffs and steep slopes, whereas yellow-billed forms nest mainly on low, flat areas. A difference in habitat preference at sea resulted in a parapatric distribution: orange-billed birds away from colonies concentrated in nearshore waters off the coast of the Americas, whereas the yellow-billed forms foraged much farther offshore. Most importantly, orange- and yellow-billed birds paired assortatively where they nested sympatrically. Thus, based on morphological and biological differences, including assortative mating, we recommend that *Sula granti* be recognized as a separate species, the Nazca Booby.

Oral Presentation

DATA ON KNOWN-AGED CASSIN'S AUKLETS AT SOUTHEAST FARALLON ISLAND, CALIFORNIA

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Recruitment, nest relocation patterns, age of first breeding, and the effects of age and experience on reproductive success were examined for 706 breeding attempts by 267 known-age Cassin's Auklets (*Ptychoramphus aleuticus*); 123 females, 137 males, 7 of unknown sex) breeding on Southeast Farallon Island, California. Mean age of first breeding was 3.34 yrs ($\pm$1.32 SD; range 2-10 yr, mode 3 yrs, with 95.5% between 2 and 5 yrs). Mean natal dispersal distance was 15.83 m ($\pm$23.95; range 0[n=4] to 227.6 m). During 71.8% of nest relocations (X^2=15.02, P = 0.000 compared with 50%), birds moved nearer to their natal site. Adjusting for effects of year, reproductive success showed significant linear increases with both age and previous breeding experience. Effects of age appeared to be stronger than those of experience. An examination of lifetime reproductive success indicated that 4 was the optimal age to initiate breeding, compared with 3 as the most frequently observed age of first breeding. No sex-specific patterns were found relative to any of the above parameters.

Oral Presentation

METHODS TO ESTIMATE EFFECTS OF AN OIL SPILL ON WATERBIRDS IN NORTHERN CALIFORNIA

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We investigated the effects on the waterbirds of a small spill of about 5,000 gallons on November 5, 1997 within Humboldt Bay and as it moved offshore. We documented the daily progress of the spill over 10 days. With systematic boat surveys, we estimated the numbers of birds within and in the path of the spill. By 13 November oil had disappeared from most areas, and the number of oiled birds and the percentage of oil on plumages had greatly declined. We will discuss preliminary examples of methods of determining the total number of birds affected by a spill, using the Marbled Murrelet and Common Murre as examples.

Oral Presentation

CORRELATION OF INLAND RADAR COUNTS AND MARINE POPULATIONS OF MARBLED MURRELETS IN WASHINGTON AND OREGON: A PILOT STUDY

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Marbled murrelet densities on the inland waters of Hood Canal, Puget Sound, were estimated from line transect surveys conducted once per month during the summer of 1997, concurrent with radar sampling at three adjacent drainages. Marine population estimates within 20 km, 30 km, and 40 km of radar sites were compared with radar counts. Monthly changes in densities were consistent within the 20-, 30-, and 40-km radii, and generally followed the trend of radar counts. Both marine densities and radar counts peaked in July, although the proportional increase in marine densities was much higher than that of radar counts. As expected, population estimates were larger than absolute radar counts, although the degree of difference depended on how the marine population was estimated. Comparable radar counts and a lower marine population estimate within 20 km of the radar sites in June and July suggest that the potential population from which inland flights originate extends beyond 20 km in the WA study area. Radar and marine counts from the Oregon coast will be compared to results from Puget Sound. We discuss the implications of using marine counts and radar as complimentary techniques in a regional monitoring program, and provide recommendations for future research

Oral Presentation

RED-FOOTED BOOBIES INCREASE AND EXPAND DURING LAST 50 YEARS

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Red-footed Booby populations have increased and expanded during the last 50 years and colonized three sites; two colonies on the main Hawaiian islands and one in the Northwestern Hawaiian Islands. Sharp population increases in the 1970s, occurred during a period of high oceanic productivity associated with the Aleutian Low Pressure System, a component of the Pacific Decadal Oscillation (PDO) which increases ocean mixing. After oceanic productivity declined in the late 1980s, booby reproductive success declined. But population growth continued and since 1990, the populations of boobies have increased 60%. During this period, the tuna fishery in Hawaii continued to increase fishing effort and landings. Removal of predatory tuna may allow more prey to be available to boobies. Boobies may benefit from the removal of competitors but their commensal relationship with tuna requires tuna to drive prey to the surface. Either boobies are not fully commensal but rather opportunists, or there is a point when depleted tuna stocks will not be able to drive enough food to the surface to support the expanding booby populations.

Poster Presentation

IDENTIFICATION OF MARBLED MURRELET NESTING STRUCTURES: A GUIDE FOR DETERMINING SUITABLE FOREST HABITATS IN THE PACIFIC NORTHWEST.

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In recent years, the continuing efforts of researchers to identify and characterize Marbled Murrelet nesting sites has led to a better understanding of what constitutes most suitable Marbled Murrelet forest habitats. The availability of nesting structures in a forest canopy has been shown to be a principal element in forest stands with high levels of murrelet activity. Nest selection appears to be highly dependent upon the availability of potential nesting surfaces, or platforms. The suitability of a stand is enhanced by processes which contribute to the number of potential nesting platforms. This field guide was developed to assist landowners and managers with implementation of the recently adopted forest practices rule in Washington state. It should also be helpful to others involved in management or research in the Pacific Northwest, for identifying forest structures that may contribute potential breeding habitat. A brief description of forest stand types utilized for murrelet breeding; a general platform definition; sampling methodology; and descriptions, illustrations and photographs of platform types are included.

Poster Presentation

POPULATION DECLINES AMONG COMMON EIDERS BREEDING IN THE BELCHER ISLANDS, NWT

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Information regarding the status of Common Eiders breeding in the Canadian Arctic is lacking. in 1997, we surveyed five island archipelagos in the Belcher Islands in Hudson Bay from 3-23 July 1997. Our results were compared with surveys of the same islands completed between 1987-89 using a standard protocol. This study represents the first population trend data of any common eider population breeding in the eastern Canadian Arctic. 1416 nests were found on 431 islands; most (94.1%) while the female was still incubating. In every region, the number of nesting eiders declined significantly (overall 75%, range: 62.3%-84%). In 1997, nesting islands and adjacent waters were free of ice, eiders laid large clutches (range 4.0-4.4 $\pm$ 1 SD), and they nested early. These conditions are indicative of a good nesting season, and we conclude that extensive non-breeding by female eiders in 1997 does not account for the decline. A winter die-off of eiders in 1992, which occurred when areas of open water froze, is the most likely cause of the decline. Our results present serious conservation concerns because eider populations are sensitive to reductions in adult survival, and this population is harvested throughout the year by subsistent hunters.

Oral Presentation

FORAGING HABITS OF THE CALIFORNIA LEAST TERN IN AND AROUND SAN DIEGO BAY

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The foraging habits of the California Least Tern were studied during four of its breeding seasons in San Diego Bay. The marine environment around San Diego Bay was divided into 32 polygons and each polygon was categorized as one of six foraging habitat types: ocean, channel, shore, inlet, mooring, or dock. Each breeding season was divided into four stages: courtship, egg, chick, and fledge. Transects were run via boat to determine whether Least Terns preferred to forage in specific habitats and/or locations. For each breeding season of each year, the majority of the polygons were not used. For years in which the study spanned the entire length of the breeding season (1994 and 1995), approximately 30% of the polygons not used at the beginning of the breeding season were consistently not used throughout the entire breeding season. Those polygons that were moderately or highly used varied both within and among years. Together, this suggests that locations in which no food is found are more significant, in terms of Least Tern foraging habits, than those in which food is found. Although there did not appear to be any preferred locations for foraging, there were two habitat types that appeared to be used more than others. These were the mooring and inlet habitats.

25th Anniversary Symposium Oral Presentation

RECENT ADVANCES IN ECOLOGICAL ENERGETICS AND NUTRITION OF SEABIRDS

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The field of avian energetics has seen major advances in the last 25 years, and seabirds have played a prominent role as models. Energy has been used as a currency for (1) assessing the fitness consequences of life history traits, (2) determining the impact of seabird predators on their prey, and (3) understanding the role of seabirds in marine ecosystems. Paradigm shifts in ecological energetics (e.g., optimization of energy allocation for reproduction) plus technological breakthroughs (e.g., doubly-labelled water) have resulted in considerable progress in understanding seabird life histories, especially time-energy constraints on reproduction. Associated with these constraints, some seabird taxa have evolved unique digestive strategies or abilities to digest refractory compounds. Only recently, however, have potential limiting nutrients other than energy been examined for their role in constraining seabird productivity. The nutritional ecology of seabirds promises to be an active area of research and discovery in the next quarter century, as will the continued expansion of bioenergetic approaches to understanding the foraging ecology of seabird populations and their role in marine ecosystems. The latter will be especially important for efforts to conserve seabird populations in the face of declines in food supply due to competition with fisheries and climatic change.

Poster Presentation

CASPIAN TERN PREDATION ON JUVENILE SALMONIDS IN THE COLUMBIA RIVER ESTUARY

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Recent establishment of a large Caspian Tern breeding colony on a dredge spoil island in the Columbia River estuary has raised concern over the potential impact on endangered salmonids. Photo census in 1997 indicated the colony exceeded 8,000 nesting pairs, the largest known Caspian Tern colony in North America, and more than a 600% increase in numbers since the colony became established in 1987. Nesting success, however, was very low; only about 5% of nesting attempts resulted in young raised to fledging. Diet in 1997 consisted of 86% juvenile salmonids, mostly coho and chinook smolts. The density of smolt PIT tags deposited on the surface of the colony indicates that the Caspian Tern population consumed millions of smolts in both 1996 and 1997. Bioenergetics modeling yielded a preliminary estimate of from 6 to 20 million juvenile salmonids consumed during the 1997 breeding season, a significant proportion of the smolt out-migration. Management alternatives focusing on Caspian Terns in the estuary may be effective and efficient components of a comprehensive plan to restore Columbia River salmon.

Oral Presentation

CENTRAL CALIFORNIA SHORELINE SURVEYS

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The Gulf of the Farallones National Marine Sanctuary conducts monthly and bimonthly surveys along 58 beach segments from Bodega Head (Sonoma County) to Año Nuevo (San Mateo County). Surveyors count coastal birds and quantify human beach use. We reviewed data from 13 beaches from October 1993 through June 1997. Representative analyses are presented. The most commonly observed species overall were Sanderlings (17.6/km surveyed), Brown Pelicans (13.2/km), Western Gulls (8.2/km), and Surf Scoters (6.3/km). The most abundant species and their numbers varied seasonally: during the Davidson period (November - February) Sanderlings (18.8/km) were the most abundant, followed by Surf Scoters (9.1/km) and Willets (5.1/km); during the Upwelling period (March - August), Sanderlings (10.4/km), Brown Pelicans, 4.6/km) Western Gulls (4.2/km), and Surf Scoters (4.8/km); during the Transitional period September - August), Heermann's Gulls, (13.5/km), Brown Pelicans (11.8/km), and Western Gulls (10.9/km). Abundance of shorebirds was negatively correlated with the presence of people (r = -0.48) and dogs (r = -0.45).

Oral Presentation

EFFECTS OF DIET QUALITY ON POST-NATAL GROWTH OF SEABIRDS: CAPTIVE FEEDING TRIALS.

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Declines in the availability of certain schooling forage fishes (sand lance *Ammodytes hexapterus*, herring *Clupea harengus*, capelin *Mallotus villosus*) have potentially contributed to the lack of recovery of some fish-eating seabirds that were injured by the *Exxon Valdez* oil spill. These forage fish tend to have high lipid content and, consequently, are assumed to have high nutritional value as food for nesting seabirds. This study tests the hypothesis that composition of the diet is one factor constraining the growth and development of piscivorous seabirds. We raised seabird nestlings (Black-legged Kittiwakes *Rissa tridactyla* and Tufted Puffins, *Fratercula cirrhata*) in captivity on rations of either capelin, sand lance or herring as representative of high-quality forage fish, or walleye pollock (*Theragra chalcograma*)as representative of low-quality forage fish. Experimental treatments included iso-biomass and iso-caloric comparisons of chick growth between low- and high-lipid fish types. Seabird nestlings fed rations of either sand lance, herring or capelin had much higher growth rates of body mass and somewhat higher growth rates of wing length than nestlings fed the same biomass of pollock. Differences in mass gain between nestlings fed capelin/sand lance/herring vs. pollock were more pronounced than differences in wing growth, suggesting that undernourished nestlings allocate food intake more to structural development than body mass. We conclude that when provisioning rate of seabirds to their young is constrained, the lipid content and nutritional quality of forage fish fed to nestlings has a marked effect on growth rates, and potentially, on reproductive success.

Poster Presentation

MURRE POPULATION COUNTS IN THE BARREN ISLANDS, ALASKA

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The Barren Islands in the northern Gulf of Alaska supported one of the largest breeding concentrations of murres (mostly Common Murres) in the path of the *Exxon Valdez* oil spill. During 1993-1997, we censused these populations as part of a series of *Exxon Valdez* Oil Spill Trustee Council-sponsored restoration studies designed to monitor postspill changes in numbers of birds attending the colonies. Counts were made from boats by two observers using standard Fish and Wildlife Service (FWS) protocols. Results were pooled with 1989-1992 FWS, 1990-1992 University of Washington (UW), and 1991 Dames & Moore (D&M) data and tested for trends with linear regressions at the 0.1 significance level. Although trends were not apparent in some postspill data sets, significant increases on two plot sets and the fact that the 1997 counts were as high or higher than any of the 1989-1996 counts suggested that murre numbers may be starting to increase at the colonies. The presence of large numbers of nonbreeders in 1997, probably 3- and 4-year-old subadults from the strong 1993-1994 cohorts, also suggested that population recovery is underway.

Poster Presentation

REPRODUCTIVE PERFORMANCE AND HABITAT SELECTION OF XANTUS' MURRELETS ON SANTA BARBARA ISLAND, CALIFORNIA.

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Santa Barbara Island, California, supports the largest breeding population of Xantus' Murrelets in the United States. Channel Islands National Park has been monitoring the reproductive performance of Xantus' Murrelets on Santa Barbara Island since 1983. In 1997, we established two new plots in which potential sites were checked for occupancy and reproductive performance throughout the breeding season. We also investigated habitat characteristics of Xantus' Murrelet breeding areas. Specifically, we measured percent cover, density, and volume of shrub species. Our objectives were to (1) calculate an unbiased occupancy rate for Xantus' Murrelets on Santa Barbara Island, (2) compare reproductive performance and occupancy between plots, (3) investigate trends in reproductive performance and occupancy from 1983 to the present, and (4) identify factors that may affect Xantus' Murrelet site selection.

Poster Presentation

THE COLONIZATION OF SOUTHERN SAN FRANCISCO BAY BY THE CALIFORNIA GULL FROM 1980 TO 1997.

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Here we report the first breeding colony of California Gulls (*Larus californicus*) in coastal California. We document its increase in population, and the establishment of satellite colonies from 1980 to 1997. Breeding populations of California Gulls have typically occurred on lakes of the Great Basin and east of the Cascade-Sierra axis including a large colony at Mono Lake, California. In 1980, a breeding colony of 12 California Gull nests was discovered on a series of small islets on Salt Pond A6 near the town of Alviso, Santa Clara Co., California. The population of California Gulls at this site has increased, reaching 1,111 nests in 1985 and 3,618 nests in 1995. Smaller colonies have since formed on salt pond levees at five other sites in southern San Francisco Bay. In 1997 there were 5067 nests at all sites. These colonies have been subjected to predation by introduced Red Fox (*Vulpes vulpes*). This predation has been followed by abandonment and reductions in breeding populations at several colonies. Additionally, there is a significant reduction in mean clutch size at several colonies where predation and population reductions have occurred.

Poster Presentation

APPLICATION OF DIP NET CAPTURE TECHNIQUES TO ESTIMATE JUVENILE RECRUITMENT IN WINTERING POPULATIONS OF MARBLED MURRELETS

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Earlier success using spotlighting and dip netting as a capture technique for Marbled Murrelets in Desolation Sound, B.C. during the summer of 1997 has led to expansion of capture efforts for Marbled Murrelets in the Strait of Georgia during the winter of 1997-98. Dip netting is a relatively inexpensive capture technique that has the potential to yield high numbers of captures in a short time. Birds located on the water during the night are identified using a hand held spotlight, and are caught in a dip net while transfixed by the light. Captured birds are banded, weighed, measured, bled and released. By coupling dip netting with recent advances in distinguishing juveniles from winter plumage adults may allow us to calculate a ratio of juvenile/adult birds, which is an index of juvenile recruitment. Capturing birds using this method may also allow researchers to quantify juvenile/adult distribution of Marbled Murrelets in wintering areas, compare seasonal body condition of recaptured birds, permit survival estimation through application of mark/recapture models, and to band known age birds for future demographic studies.

25th Anniversary Symposium Oral Presentation

SPATIAL SCALING: THEORY AND APPLICATIONS IN MARINE ORNITHOLOGY.

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Ecological questions in conservation biology, resource management, and impact assessment typically arise at medium to large scales, while ecological and ethological studies are carried out at small scales. One approach to this problem has been to ignore it. Another has been to define subsystems within a system, introducing correction factors as needed if summation is inaccurate. These correction factors are empirical, and hence cannot be applied to new situations. A theoretical approach is need to obtain predictive scalings that can be tested against new data, then used to scale reliably from a survey or experiment to larger scale questions. Recently developed graphical methods make it possible to predict which of two rates will prevail at the scale of a study and at the scale of an ecologically important question. These graphs indicate that demographic rates (recruitment and mortality) do not scale as $Area^0$ nor do kinematic rates (lateral movements) scale as $Area^{-1/2}$. Spatial allometry considers the scaling of rates to areas, lengths, perimeters, and volumes according to the principle of similitude introduced into biology by Thompson in 1917. Two ratio scale variables Q and Y are allometrically similar if they scale according to an exponent (b not equal 1) within a stated scope Y/Y_0.

$$Q / Q_0 = (Y / Y_0)^b \qquad \text{Hence:} \quad Q = a\,Y^b$$

Spatially allometric functions have been developed for geophysical variables including coastline lengths, habitat islands, and rainfall. The next step will be to develop testable spatial scaling functions for biological rates. Marine birds, both on colonies and at sea, offer many opportunities for this. Marine ornithology continues to offer opportunities to make important and broadly applicable contributions to ecological theory.

Poster Presentation

A COMPARISON OF BLOOD PARAMETERS BETWEEN PIGEON GUILLEMOT (*CEPPHUS COLUMBA*) COLONIES OF PRINCE WILLIAM SOUND AND KACHEMAK BAY, ALASKA

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Seven years after the *Exxon Valdez* oil spill, pigeon guillemot census counts at the Naked Island colonies continue to remain lower than pre-spill levels. It is unclear whether recovery is being limited by demographic constraints, food availability, or the physiological effects of oil contamination. We are studying these issues by comparing blood chemistry of pigeon guillemots between the oiled colonies of Naked Island, Prince William Sound and Kachemak Bay, which was not oiled in 1989. In 1996, several differences in the blood chemistry indicate a heightened immune response in pigeon guillemot chicks at Naked Island in comparison to Kachemak Bay. Higher Lymphocytes and gamma globulin are strong evidence for a heightened immune response. Heightened levels of liver enzyme SGOT are also, consistent with a heightened immune response. The acute phase protein, haptoglobin was significantly higher at Kachemak Bay. A logistic regression indicates that gamma globulin level alone largely distinguishes chicks between Naked Island and Kachemak Bay. The combination of gamma globulin, bile acid and phosphorus in a logistic regression model correctly classifies 53 of 54 chicks as from either Naked Island or Kachemak Bay.

Oral Presentation

AVOIDING SEABIRD BYCATCH IN ALASKA LONGLINE FISHERIES

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In 1995 commercial longliners fishing off Alaska caught two Short-tailed Albatrosses; in 1996 they took a third. The Short-tailed Albatross is one of the world's most endangered albatrosses - there are some 200 mating pairs and perhaps 900 birds alive today. The longline industry immediately developed a set of seabird-avoidance regulations modelled in part on the CCAMLR regulations for longline fishing in the Antarctic. These regulations were implemented in record time by the Secretary of Commerce. Assisted by federal agencies, Sea Grant, the Audubon Society, a private foundation and several private industry groups, the fishermen then engaged in a massive outreach program to get the word to the fleet. They also consulted with Dr. Hiroshi Hasegawa of Toho University, Japan, the world authority on the life-history of the Short-tailed Albatross. This presentation will review the reasons for and extent of the decline of the Short-tailed Albatross population, and Dr. Hasegawa's pioneering work to restore it. It will discuss the legal and political realities surrounding the longline fisheries under the U.S. Endangered Species Act, and will describe the development and implementation of the seabird avoidance regulations. Finally an at-sea experiment is being devised to test the efficacy of the various seabird-avoidance fishing techniques and gear.

Poster Presentation

A SHIPWRECK RESPONSE PROGRAM TO PREVENT “RAT SPILLS” IN ALASKA

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Much attention has been focused damage to seabirds from oil spills, but less well publicized is the damage done by introduced rats on seabird nesting islands. Rats could be far more damaging than oil spills since rats survive even after wildlife populations are eliminated or reduced. Rats have been introduced to at least 22 islands in Alaska. Although intensive studies have not been done, it is apparent that burrow-nesting seabirds have been extirpated by rats, and these rodents also have reduced populations of crevice-nesters and possibly surface-nesters. Although rats have been successfully removed from several small islands in the world, such operations are costly and currently confined to fairly small islands. Clearly prevention of further introductions is a high priority. Ship wrecks are the primary means of introducing rats on uninhabited islands. Recently, the U.S. Fish and Wildlife Service, U.S. Coast Guard, Magone Marine (a ship salvage company) and others have developed a shipwreck response plan including development of a response network, stockpiling response supplies at strategic locations, training people in procedures, and increasing awareness about the problem.

25th Anniversary Symposium Oral Presentation

HUMAN INFLUENCES ON BREEDING MARINE BIRDS OF THE NORTHEAST PACIFIC OCEAN – THE PAST 20,000 YEARS

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Human activities are known to significantly impact marine birds at nesting sites. Colonies at the continent edge of the Northeast Pacific Ocean have been exposed to human influences since the last ice maximum, perhaps to 20,000 years before present. Did, could have, the First Americans significantly altered the abundance or distribution, or caused extinction, of marine avian species? Have the New Americans done the same? Has the form and extend of influences changed over time? How do these differ between the two groups, over time and between locations? Locations if California, Washington-British Columbia and Alaska are compared. Northeast Pacific Ocean sites are compared to those in tropical Pacific Ocean areas, where people of different origins and cultures first colonized oceanic islands. Archaeological, cultural, and recorded observations are utilized to explore and evaluate the above questions and developed hypotheses.

Poster Presentation

PATTERNS OF SEABIRD ABUNDANCE IN ASSOCIATION WITH OCEANOGRAPHIC FEATURES AT THE NORTH PACIFIC SUBTROPICAL FRONTAL ZONE.

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During the spring of 1997 (25 April - 19 May), a survey of pelagic seabirds was performed concurrent with an investigation of the physical and biological oceanography of a broad region north of the Hawaiian Archipelago known as the North Pacific Subtropical Frontal Zone (NPSF) aboard the NOAA Ship *Townsend Cromwell*. The front is characterized by mesoscale features in the form of meandering fronts and frontal eddies in various stages of formation and decay. Seabird census transects (n = 127) were performed using a 300-m zone width and a 90° observation quadrant. Transects were 30 minutes in duration and were performed during daylight while the ship was underway between oceanographic stations. A number of long-term and several shorter duration studies have previously shown that seabirds have distinct affinities for water masses and physical oceanographic features. However, little attention has been directed at examining the role of mesoscale events induced by secondary divergent and convergent flow as important episodic habitat features for seabirds in this region of the central North Pacific Ocean. Seabird density is presented for species and species groups in relation to sea surface temperature and salinity, thermocline depth, and deep chlorophyll maximum depth and concentration. Ecological significance and future research considerations are discussed.

Poster Presentation

THE PACIFIC SEABIRD MONITORING DATABASE - A DESKTOP INFORMATION SYSTEM FOR NORTH PACIFIC SEABIRDS

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A 1992 Pacific Seabird Group survey of past and present seabird monitoring efforts in the temperate North Pacific indicated that upwards of 10,000 observations on seabird population parameters are available for North Pacific colonies. In a cooperative effort directed by the members of the PSG Seabird Monitoring Committee, the Pacific Seabird Monitoring Database was developed as a means of making these largely inaccessible data available to potential users in a timely manner. The database stores data on the 86 species that breed in the Pacific north of 20° N and incorporates a variety of population parameters including abundance, productivity, reproductive success, diet composition, and survival. Data to be collated in the database consists of observations replicated over time and of sufficient quality to permit meaningful trend and variability analyses. Each observation represents a yearly estimate of a particular population parameter for a given species in a given location. The database utilizes a run-time version of Microsoft Access for data entry, editing, querying, reporting and exporting, and includes Geographic Information System databases to be used with ArcView 2.1 for regional database querying, mapping, and spatial analysis capabilities. Currently, the database contains over 10,000 observations from four Pacific states (Alaska, Oregon, Hawaii and California), British Columbia, and the Russian Far East.

Oral Presentation

FORAGING LOCATIONS OF MAGELLANIC PENGUINS IN THE SOUTH ATLANTIC

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Breeding Magellanic Penguins forage farther from their nest sites than was suspected prior to the recent use of satellite telemetry to track penguins at sea. We have tracked Magellanic Penguins breeding on the Argentine coast for three years, and have found consistent patterns among seasons. During the incubation and late chick-rearing stages, breeding adults forage hundreds of kilometers from the nest site. Around the time of egg hatching and early chick-rearing, adults forage closer to the colony, but still make trips of tens to more than 100 kilometers. Such long distance foraging in a swimming bird imposes major constraints on rate of food delivery to, and consequently growth and survival of, chicks. In this paper, we compare Magellanic Penguin foraging patterns within and among years. Within the general patterns that are similar in all years, individuals differ markedly in their foraging locations; these locations appear to be consistent between trips. We also now have indications that penguins breeding in different colonies forage in the same area, indicating the possible use of regional foraging grounds.

Oral Presentation

MARBLED MURRELET DISTRIBUTION SHIFTS BETWEEN COASTAL HABITATS OF NORTHERN CALIFORNIA AND OREGON.

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A consistent seasonal change in the distribution of Marbled Murrelets relative to coastal nearshore habitat along the northern California and Oregon coast is described. Relative abundance decreased off most sandy shorelines and increased off from rocky shorelines in August compared with June. The shift in distribution occurred between late July and mid-August in each of 5 years, after many juveniles had fledged to sea and when most after hatch-year murrelets were entering the advanced stages of prebasic molt. This distribution shift has implications for monitoring the abundance and reproductive success of murrelets. Changes in the prey base, reproductive status, and molt condition of the murrelets are discussed as factors potentially related to the shift in distribution.

Poster Presentation

FORAGING ECOLOGY OF BLACK-LEGGED KITTIWAKES IN PRINCE WILLIAM SOUND, ALASKA, FROM RADIO TRACKING STUDIES.

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A nonlinear relationship between foraging effort and reproductive success has been described for seabirds. The mechanisms and limitations of this relationship, however, are poorly understood. We studied the reproductive performance and at-sea foraging activities of kittiwakes during five seasons at colonies in north, central, and southern Prince William Sound (PWS). Mean annual foraging trip duration and distance from colony (linear distance over water to furthest foraging location) ranged from 1.7 hrs and 4.6 km for birds from a colony in central PWS to 6.0 hrs and 60.0 km at a northern colony. Adult kittiwakes were not able to maintain average nestling growth (16 to 17 g/day) when mean foraging trip durations were > 6 hrs and mean trip distances were > 40 km. Nestling diets were primarily pacific herring, pacific sand lance, and capelin. Foraging trip distance from colonies in central and northern PWS was inversely related to percent occurrence of herring in nestling meals. Greater mean trip distances were primarily associated with foraging locations around the southern boundary islands (near the Gulf of Alaska) where schools of sand lance and capelin were more prevalent than herring.

Oral Presentation

TEMPORAL SHIFTS IN FISH AND ZOOPLANKTON SPECIES COMPOSITION IN SEABIRD CHICK DIETS OFF CENTRAL CALIFORNIA INDICATE MARINE CLIMATE CHANGE.

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We used time series data (10 to 25 years) to assess temporal variation in prey composition of chick diets for 4 seabird species that breed on Southeast Farallon Island (37ºN 123ºW). The most prominent shift indicated from the three piscivorous species was a decline in proportion of juvenile rockfish fed to chicks. Prior to 1989 in years lacking warm-water anomalies, juvenile rockfish, mainly *Sebastes jordani*, made up more than 50% of the diet of Common Murre, Rhinoceros Auklet, and Pigeon Guillemot chicks. For the two species that forage farthest from the island, Rhinoceros Auklets and Common Murres, the proportion of northern anchovy increased in the 1990s. Pigeon Guillemots fed on cottidae species and other inter and subtidal fishes more frequently in the 1990s. Planktivorous Cassin's Auklets foraged mainly on the euphausiid *Thysanoessa spinifera* during the 1970s and early 1980s. Beginning in the mid 1980s the proportion of *Thysanoessa* in chick diets declined as the smaller euphausiid *Euphausia pacifica* increased. The decrease in prevalence of *Thysanoessa* and juvenile rockfish from the 1970s to the 1990s occurred during a period of general ocean warming and may be explained by a change in upwelling in the region.

Oral Presentation

SEASONAL CHANGES OF FOOD AND CHICK GROWTH IN RHINOCEROS AUKLET AT TEURI ISLAND: COMPARISON BETWEEN YEARS.

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Regulation of food provisioning by parents in relation to chick growth has been studied extensively among seabirds during the last decade. To examine how parents adjust the provisioning to the potential food requirement of chicks, the seasonal changes of food and chick growth of Rhinoceros Auklets were measured for three years at Teuri Island. The fish species in bill-loads changed from juvenile Japan sea greenling, to sand lance, then to anchovy as the season progressed, in all years. Anchovy became predominant in late June and early July in 1995 and 1996, but not until late July in 1997, so the seasonal pattern of fish composition showed large annual variation. As the bill-loads composed of anchovy (c.30 g) were larger than those of sand lance (c. 20 g), the bill-load sizes peaked in late June and early July in 1995 and 1996, but in late July in 1997. The amount of food received by chicks and chick growth rates showed similar seasonal patterns. Fledging success was poor in 1997 (67%) compared to 1995 (81%) and 1996 (77%). Therefore, the timing of anchovy appearance is important for chick production. Parents might feed their chicks not by adjusting the food requirement of chicks, but largely according to the seasonal availability of their prey.

Oral Presentation

THE UNITED KINGDOM SEABIRD MONITORING PROGRAMME: USE OF SEABIRD BREEDING PERFORMANCE AS AN ALERT FOR CHANGES IN THE MARINE ENVIRONMENT.

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A co-ordinated, integrated monitoring programme at seabird colonies in the UK has been in operation for a decade. By the use of standardised methods to record breeding parameters such as chick output per nest, it is possible to describe changing spatial and temporal patterns in these parameters. This provides nature conservation organisations and others with a tool to provide an early alert on potential conservation problems. Several examples of the results of identifying such change will be given. Monitoring of productivity at Arctic Tern colonies in Shetland in the mid 1980s provided an early indication of a collapse in the local sand lance stock. A reduction in Black-legged Kittiwake breeding success on the east coast of Scotland led to concerns over the effects of the large-scale industrial fishery for sand lance in the feeding areas for colonies in this region. This concern has triggered a research programme on these possible links. Finally, the effects of two large oil spills on UK coasts can be put in context of natural variation in breeding numbers and productivity.

Oral Presentation

DEMOGRAPHY OF THE BLACK SKIMMER IN SOUTHERN CALIFORNIA

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Black Skimmers first began nesting in California in 1972. Since then, skimmers have expanded northward into eight breeding colonies. Two of the largest colonies of breeding skimmers in the state are at the Upper Newport Bay and Bolsa Chica Ecological Reserves. In this study, I examine the demographics of the Black Skimmers at these two sites and, with the aid of a life table analysis, estimate the life expectancies of these birds through their various stages of life. Also, I compare southern California demographics with other studies done on skimmers throughout North America as well as with other related species. Data on phenology, clutch size, hatching success, fledging success, survivorship, mortality and life expectancy are presented. Southern California skimmers were found to follow the same general reproductive patterns as east coast and southern skimmers. Success rates were found to be slightly lower here, but not enough to cause a net loss in population sizes. The Black Skimmer is an avian species that has shown an increase in population size due to good reproductive success and immigration.

Poster Presentation

CHARACTERISTICS OF DOUBLE-BROODING IN CASSIN'S AUKLETS (*Ptychoramphus aleuticus*)

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Cassin's Auklets have a long incubation and nestling period, and yet on Southeast Farallon Island (SEFI), California, pairs have occasionally produced two successive clutches in a season. Double-brooding is rare in other seabirds, particularly other auklet species which inhabit more northern ranges and experience shorter breeding seasons. Breeding of Cassin's Auklets in nest boxes has been monitored on SEFI for 25 years (1972-1996). Our objectives are 1) to determine the frequency and success rate of double-brood attempts, 2) to describe environmental factors associated with double-brooding, 3) to examine characteristics of pairs which attempted double-brooding, and 4) to discuss the adaptive significance of double-brooding. Double-brooding occurred in 15 years of the study period, but in only 8 years did more than 10% of the monitored population double-brood. From preliminary analysis, attempts at double-brooding appear to be more successful in later years of our study, and additionally resulted in heavier fledglings than in earlier years. The mean first-brood lay date was earlier in years of attempted double-brooding. From a population of individually-marked breeders, we have determined that a number of specific birds or pairs have laid second clutches in more than one year.

Poster Presentation

INTERNAL AND EXTERNAL MEASURES OF AGE AND BREEDING STATUS IN COMMON MURRES, WITH EMPHASIS ON THE BURSA.

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For many reasons it is important to determine age of seabirds. Within a few months of fledging, most seabirds, including murres, are relatively monomorphic in external plumage color and morphology, and they remain so until they die. As a result, bursa size and structure has been used for decades, often exclusively, as an indicator of reproductive potential and, indirectly, of age: Fleshy, thick-walled bursa = hatch-year to young subadult; non-fleshy, thin-walled bursa = reproductively immature subadult; membranous or absent bursa = reproductively mature adult. Similarly, in the absence of bursa data, birds with "full" size gonads have been assumed to be reproductively mature. However, both the literature and bursa data from Common Murres indicate that about 15% of breeding murres have thin-walled bursae, making bursa size alone an unreliable indicator of reproductive status. Similarly, birds with "fully enlarged" gonads often have fleshy bursae indicating that gonad condition alone is not a reliable indicator of reproductive maturity. We discuss these data in combination with data on bill length, bill depth, skeletal structure, and timing and extent of flight feather molt (and resulting plumage patterns), and how these data may be used to determine age and breeding status of murres more accurately.

Oral Presentation

MOLECULAR AND PHYSIOLOGICAL INDICATORS OF REPRODUCTIVE STATUS IN MARBLED MURRELETS

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Marbled Murrelets (*Brachyramphus marmoratus*) are sexually monomorphic seabirds (Alcidae) that breed in stands of old growth forest. The threats to such habitats raise concerns for the future conservation of this species, and point to the need for methods that can detect changes in Marbled Murrelet population demographics. The Marbled Murrelet's cryptic nesting behavior has made estimating even basic demographic parameters difficult. Blood and plasma samples were collected from Marbled Murrelets by mist-netting at Desolation Sound, British Columbia over four years (1994-1997), and dip-netting at both Desolation Sound, and Mussel Inlet, British Columbia during the 1997 field season. Red blood cells serve as ample sources of DNA for the application of a novel molecular sexing technique, that was verified using DNA extracted from known-sex Marbled Murrelet museum specimens. Plasma triglyceride levels are greatly elevated during egg-formation, and serve as a means by which potential fecund (egg-producing) females may be identified within a sample of captured birds. We present sex ratio and plasma triglyceride levels of captured Marbled Murrelets, along with comparative studies in Cassin's Auklets, sampled on Triangle Island, British Columbia.

Poster Presentation

THE ECOLOGY OF BREEDING HARLEQUIN DUCKS IN A ROCKY MOUNTAIN VALLEY.

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We have studied the breeding ecology of the Harlequin Duck, *Histrionicus histrionicus*, in the Maligne River Valley, Jasper National Park, since 1991. Our objective is to explain the abundance and distribution patterns of harlequins in this watershed. Macro-invertebrate community dynamics appear to be the major causal factor. Harlequins adopt either a territorial or mate-defense strategy for breeding in this valley. A few pairs of territorial birds breed on the Maligne River, while the majority are non-territorial and use one of two strategies: feeding at gathering , or 'club', sites at the Maligne Lake Outlet (MLO) and Medicine Lake, or spreading out around the lake margins to feed. These birds then move to higher elevation tributaries for nesting. We believe that the large variations in harlequin numbers observed at the MLO are likely caused by seasonal fluctuations in density and diversity in the invertebrate community. Understanding this phenomenon is crucially important for park management issues, as the Maligne River watershed is a high-use recreational area.

Poster Presentation

MOLECULAR INVESTIGATIONS INTO MECHANISMS OF SPECIATION IN THE AUKLETS (CHARADRIIFORMES: ALCIDAE)

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The conventional model of allopatric speciation does not provide satisfactory mechanisms for many evolutionary phenomena, such as adaptive radiations. Alternative models, such as those for parapatric, peripatric, and sympatric speciation, therefore have been proposed. The number and distribution of alleles within and among populations can provide clues as to the nature of historical population dynamics (bottlenecks, for example) causing or contributing to speciation. Four of the five species of auklets appear to have diverged within a short period during the late Pliocene or early Pleistocene, and their evolutionary relationships have been unclear despite over 3000 base paris of mitochondrial sequence data analyzed. In the present study, we applied molecular methods to investigate mechanisms of speciation in the auklets. To determine whether species may have arisen through the founder-effect model of peripatric speciation, geographic variation in the MHC genes is being assayed to estimate effective population size at speciation. Analysis of nuclear introns and internal transcribed spacer regions of nuclear ribosomal DNA from individuals throughout the breeding range of the auklets are providing information concerning effective population sizes at different depths in the evolutionary history of these species. We also are attempting to determine whether ecological factors such as climate cycles, glacial refugia, and mutual sexual selection of ornamental characters played a major role in speciation within this group.

Oral Presentation

FORAGING CHARACTERISTICS OF COMMON MURRES; POTENTIAL INTERACTIONS WITH A SAND LANCE (*AMMODYTES* SPP.) FISHERY

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We present preliminary results of a multi-disciplinary program investigating the effects of large-scale industrial fisheries on non-target species (ELIFONTS). The study focuses on an area off the southeast coast of Scotland which has been the site of the highest intensity of fishing recorded in the North Sea (maximum annual catch of >100,000 t of sand lance). The Common Murre is a key avian predator in the system and a major aim of this study is the determination of the foraging distribution, feeding behaviour and diet of this species. Data on foraging distribution were obtained by radio-tracking individuals and from at-sea surveys, information on behavior was collected both from the radio-tracked birds and from individuals fitted with time-at-depth gauges and diet was assessed by observations of prey brought back to provision the chicks. Results from the first field season indicate that 1 group sand lance were the most important item in the diet and that there was spatial and temporal overlap with the sand lance fishery. Individuals fed predominantly at depths of between 50-55 m, mainly on, or just above, the seabed. This finding accorded well with results from surveys of the vertical distribution of sand lance.

WHY STUDY PALEONTOLOGY? SOME ORNITHOLOGICAL ANSWERS

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Fossils are not simply a collection of bones, teeth, or impressions in rocks. Along with the morphological data one can gather from fossils is information about space and time. Each fossil and the surrounding rock provide information about morphology, when and where the fossil was deposited, and the fossils' depositional environment. From these data researchers can compare groups of fossils, possibly representing populations or ecological communities, deposited at the same time but in different places, or groups of fossils from the same place but deposited at different times. As such, fossils can be used in studies concerning (1) long term and large scale processes that have contributed to the development of extant ecological communities; (2) zoogeography of a taxon and the evolution of that taxon; and (3) morphological evolution. This talk will focus on how the study of fossils has contributed to our knowledge of seabird evolutionary processes occurring at these three scales. As examples, I will detail how fossils have furthered our understanding of the structure of north Pacific seabird "communities"; the evolution of the Alcidae, in particular the zoogeography of murres and guillemots (*Uria* and *Cepphus*); and the anatomy of Pelecaniform mandibles and the functional morphology of streptognathism.

FORAGING SITES OF JAPANESE CORMORANTS REARING CHICKS AT TEURI ISLAND:INDIVIDUAL AND BETWEEN-YEAR VARIATION

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Cormorants play an important role in inshore marine ecosystem as they consume large amounts of demersal fish. To study their response to and impact on the marine resources, it is important to know the variability of their foraging sites. Japanese Cormorants feed on demersal and epipelagic fish by diving to 10-20 m depths. We radio-tracked cormorants rearing chicks at Teuri Island in 1996 and 1997. They foraged at a single site for 81% of foraging trips either near the island (3-5 km from the colony) or the mainland coast (>20 km from the colony) with some individual site fidelity. All seven radio-tagged birds foraged mainly at sites near the mainland coast in 1996. In 1997, however, five out of ten radio-tagged birds foraged mainly at sites near the colony and the others near the mainland coast. The main diet of chicks was demersal fish (rock fish and greenling) in 1996 but both epipelagic (sand lance and naked sand lance) and demersal fish (greenling) in 1997. Therefore, availability of epipelagic fish might be one of the factors affecting their foraging distances.

Poster Presentation

ACTIVITY OF MARBLED MURRELETS AT EDGE AND INTERIOR FOREST LOCATIONS.

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Inventory methods for Marbled Murrelets in British Columbia recommended that murrelet surveys be conducted in canopy openings to maximize bird detections. However, forest interiors are the focus of habitat management for murrelets. To determine if survey location influenced the detection of murrelets, we tested whether (1) observers had similar numbers of detections in clear-cut or adjacent forest edge and (2) there were associated differences in murrelet activity between interior forest and edge stations. Seventeen sites, located in known murrelet nesting habitat in the Bunster Range, B.C., were randomly chosen along clear-cut edges. Each site consisted of three survey stations: open edge, forest edge and forest interior. Murrelet activity was recorded simultaneously at all three stations at each site. Results indicated that the total number of detections increased between May and July, 1997, but no differences in murrelet activity were detected between stations. Occupancy activity levels were higher in July for the forest interior stations, but no temporal changes in activity were detected at the edge stations. Future work should have a larger sample size, and the surveys should be combined with climbing plots to evaluate nesting density.

Oral Presentation

DIETARY PREFERENCES OF COMMON MURRES AND RHINOCEROS AUKLETS IN PUGET SOUND, WASHINGTON IN LATE SUMMER AND FALL 1993-1996

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Puget Sound is an important foraging location for large numbers of seabirds, particularly Common Murres (*Uria aalge*) and Rhinoceros Auklets (*Cerorhinca monocerata*). We present baseline data on the diet of these piscivorous seabirds collected from sockeye (late summer) and chum (fall) salmon drift gill nets in 1993-96. Overall, murres fed primarily on Pacific herring (74.2% of stomachs with contents), Pacific sand lance (45.8%), salmonid species (21.9%), Pacific tomcod (11.8%), Pacific hake (6.5%) and squid (5.9%). Auklets fed primarily on sand lance (62.3%), herring (48.1%), three spine stickleback (26.6%), squid (11.0%), tomcod (10.4%), salmonid species (9.7%), juvenile crab (7.8%) and Pacific sandfish (5.2%). Age (subadult and adult) and sex had no significant effect on the frequency of herring, sand lance, or salmonid species preyed upon by murres and auklets. Frequency of herring, sand lance, and salmonid species in the diet of both species did not vary significantly between years; however, during the sockeye fishery, murres ate significantly more herring and salmonid species than auklets. Overall, the mean length of herring and sand lance preyed upon by murres and auklets did not differ significantly. The depth and time of day at which these birds were entangled will be examined to determine their role in the foraging ecology of these species.

Poster Presentation

MANAGEMENT OF SEABIRD BYCATCH IN LONGLINE FISHERIES

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Seabirds are being taken incidentally in various commercial longline fisheries in the world. Species of seabirds most frequently taken are albatrosses and petrels in South Pacific and South Atlantic fisheries, Northern Fulmars in the North Atlantic and albatrosses, gulls, and fulmars in the North Pacific fisheries. Some of the seabird species have endangered or threatened status while others are species of management concern. Responding to the need to reduce seabird bycatch the Commission for the Conservation of Antarctic Marine Living Resources, the Commission for the Conservation of Southern Bluefin Tuna, and the N. Pacific Fisheries Management Council all adopted mitigation measures to reduce seabird bycatch in longline fisheries in 1992, 1992, and 1997, respectively. In 1997, the Food and Agriculture Organization's Committee on Fisheries agreed to conduct, in collaboration with the U.S. and Japan, the first worldwide meeting on seabird bycatch to develop a set of mitigation measures to reduce seabird bycatch in the world's longline fisheries. This technical meeting will occur in 1998; while the measures will be considered for adoption by the FAO Committee on Fisheries in 1999.

Poster Presentation

INDIVIDUAL FORAGING PREFERENCE OF THICK-BILLED MURRES DURING CHICK REARING

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Thick-billed Murres (*Uria lomvia*) at Coats Island, NWT were observed delivering prey items to chicks during 1994 – 1997. Adults were marked using coloured leg bands allowing individual recognition. Feeding watches were carried out at regular intervals throughout the chick rearing period in each year. Prey items delivered to chicks were identified to species. Using observational data collected over four years we investigate trends in selection of prey items delivered to the colony by known individuals. Despite variations in overall prey availability during the chick rearing period, our data suggest that certain individuals show a preference for particular prey species or types (e.g. benthic vs. mid-water). Following known individuals, we examine foraging strategies relating to prey preference, looking at intra and inter-seasonal differences to determine whether the same individuals maintain or alter their prey selection from year to year.

Poster Presentation

MONITORING HEALTH OF TROPICAL PELAGIC SEABIRD POPULATIONS IN HAWAII.

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Since its establishment, the Honolulu Field Station used clinical and microscopic pathology, toxicology, microbiology, and epizootiology to evaluate health of seabirds in Hawaii. From 1992-1996, the HFS examined tissues from 1775 seabirds comprising 15 species. Diseases were grouped into those causing large-scale mortality and those considered incidental. Lead poisoning from paint chips and necrotizing enteritis secondary to dehydration were major causes of mortality in Laysan Albatross chicks on Midway Atoll. Lead poisoning in Laysan Albatross chicks increased in severity with age and was more prevalent near buildings. On Oahu, unusually strong winds along with bacterial infections were responsible for large mortalities of shearwater chicks in 1994. Unusually high numbers of Laysan Albatross adults died on Midway in 1995 from acute anemia of unknown origin. In 1996, fire was responsible for deaths of Red-footed Boobies on Oahu. Incidental findings included trauma and parasitic infections such as newly described endemic blood parasites from Great Frigatebirds and Brown Boobies. At present, disease does not appear to play a limiting role in seabird populations in Hawaii. However, given the dynamic nature of disease, population health should be integrated into monitoring systems for seabirds.

Chronology of the Pacific Seabird Group Meetings and Symposia

Annual Meeting		Symposia	Chairs
1973	Bolinas, California	Organizational Meeting	
1974	Seattle, Washington (6-8 Dec)	Biology of the Alcids	J. Michael Scott
1975	Pacific Grove, California (12-14 Dec)	Seabird Conservation on the California Coast Shorebirds in the Marine Environment[1]	J. Michael Scott
1977	Pacific Grove, California (7-9 Jan)	Black-legged Kittiwake Reproduction	George Divoky
1978	Victoria, British Columbia (19-21 Jan)	Food Availability and Reproductive Success	David Manuwal
1978	Pacific Grove, California (13-16 Dec)	Investigator Bias in Assessing Seabird Nesting Success	Dan Anderson
1980	Pacific Grove, California (23-26 Jan)		Ralph Schreiber
1980	Tucson, Arizona (19-21 Nov)		Ralph Schreiber
1982	Seattle, Washington (6-9 Jan)	Feeding Ecology of Marine Waterfowl and Pelagic Birds[1] Marine Birds: Their Feeding Ecology and Commercial Fisheries Relationships[1]	Kees Vermeer
1982	Honolulu, Hawaii (1-4 Dec)[2]	Tropical Seabirds[1] Human Disturbance at Seabird Colonies	Harry Ohlendorf
1984	Pacific Grove, California (5-8 Jan)		Craig Harrison
1984	Long Beach, California (14-16 Dec)	Biology of Terns	Judith Hand
1985	San Francisco, California (4-8 Dec) [3]	Ecology and Behavior of Gulls[1] Use of Man-Made vs. Natural Wetlands by Waterbirds and Shorebirds[1]	Dan Anderson
1986	La Paz, Mexico (10-14 Dec)	Biology of Seabirds in the Gulf of California	Lora Leschner
1987	Pacific Grove, California (16-20 Dec)	Alcids at Sea[1] Marbled Murrelet Management[1]	Ken Briggs
1988	Chevy Chase, Maryland (12-16 Oct) [3]	Wading-Bird Reproduction in 1988	Scott Hatch

[1] Published symposium (Biology of Seaducks in press, Seabirds in a Changing Ocean to be published)
[2] Joint meeting with the Australasian Seabird Group
[3] Joint meeting with the Colonial Waterbird Society

Author Index

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