VULNERABILITY OF SEABIRDS TO AT-SEA ANTHROPOGENIC THREATS: VARIATION ACROSS TAXA IN THE NORTH PACIFIC

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Within the field of seabird conservation there exists a paradigm that certain human stressors such as fisheries bycatch are more important than others. Though these generally accepted patterns may be true in some locations and for some taxa, it is not clear how such vulnerability varies across space and taxonomic groupings. To address this question, we evaluated the scientific literature using a scoring system modified from Maxwell et al. (2012) to create vulnerability scores for three species of albatrosses, two species of shearwaters and petrels, one alcid, and one storm-petrel to 10 anthropogenic at-sea threats. The threats assessed were: bycatch, fisheries competition, ecosystem disturbance from fisheries, organic pollution, inorganic pollution, marine debris, operational oil spills, large oil spills, and climate change-driven changes in wind intensity and SST variability. We assessed differences in vulnerability scores between taxa at the species and family levels, finding both significant differences and similar score patterns occurred at both taxonomic levels, depending on the taxa compared. Using spatially explicit maps of 8 of the anthropogenic threats, we constructed cumulative risk maps for each taxon. Differences in vulnerability combined with variation in ranges are shown to lead to significantly different potential exposure as well as different priority locations for conservation and management efforts.

FROM OIL SPILLS AND HAZARDOUS RELEASES TO RESTORATION: SEABIRD RESTORATION PROJECTS IMPLEMENTED THROUGH THE NATURAL RESOURCE DAMAGE ASSESSMENT (NRDA) PROCESS (poster)

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In the aftermath of an oil spill, federal and state agencies that are designated as natural resource trustees may assess the injuries and make a legal claim for monetary damages for injuries to wildlife and habitat. The goal of this process, known as Natural Resource Damage Assessment (NRDA), is to restore and compensate for the injuries. During the last three decades in California, the Trustees have played an active role in restoration for oil spill and hazardous releases impacts to seabirds. Over $50 million has been recovered and invested in seabird restoration projects which span the entire State of California and in some cases include locations outside of the United States. The projects employ a diverse suite of restoration techniques. This poster presents an overview of these projects and the techniques used to benefit seabirds.

FROM CONTAMINATION TO RESTORATION: THE NATURAL RESOURCE DAMAGE ASSESSMENT (NRDA) PROCESS (poster)

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In the aftermath of an oil spill or other pollution event, federal and state agencies that are designated as natural resource trustees may assess the injuries and make a legal claim for monetary damages for injuries to wildlife and habitat. The goal of this process, known as Natural Resource Damage Assessment (NRDA), is to restore and compensate for the injuries. During the last three decades in California, the Trustees have recovered over $50 million for restoration projects to benefit impacted seabird populations. The basis for the monetary amounts is the estimated cost of the proposed restoration projects. This poster describes the NRDA process from its legal foundations, thru the injury assessment phase, to the public comment and ultimately the restoration phase, illustrating how projects are selected and implementers and contractors are chosen.

SEABIRD DIE-OFF DETECTED DURING A MAJOR COCCOLITHOPHORE BLOOM IN THE BERING SEA IN 2014 (presentation)

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In August 2014, we found evidence of a seabird die-off event in the southeastern Bering Sea, during a year with unusually warm ocean temperatures. Dead birds were encountered during U.S. Fish & Wildlife marine bird surveys in conjunction with National Oceanic and Atmospheric Administration's (NOAA) Bering-Aleutian Salmon International Survey (BASIS). Surveys were conducted from western Bristol Bay to St. Lawrence Island from 18 August – 3 October, 2014. The die-off was detected on 19 - 21 August, on 11 transects totaling 222 km, during which we recorded 31 dead birds, mainly murres (Uria spp) within 300 m of the vessel and an additional 20 birds off-transect. During the same period we recorded only 64 live murres. The main seabird die-off event covered an estimated area of 16,616 km2. The average density of dead birds in this region was 0.47 birds km-2. By extrapolation to the potentially affected area, approximately 7,800 dead birds could have been present. During the BASIS survey, corresponding oceanographic and fisheries data documented unusual conditions in the Bering Sea, including a shift in distribution of age-0 pollock similar to that observed during the last warm period (2002 – 2005). In addition, a major coccolithophore (Prymnesiophyceae spp) bloom was detected ~20 km northeast of the main seabird die-off area. Coccolithophores are nontoxic small (~ 5 μm) phytoplankton with calcium carbonate plates which give the water a cloudy/milky appearance. This taxa can flourish in the presence of nutrient poor waters, and has previously been associated with warm water, and seabird die-off event, possibly due to poor foraging conditions.

APPLICATIONS OF A MODEL-BASED U.S. ATLANTIC COAST-WIDE SYNTHESIS OF AT-SEA MARINE BIRD DISTRIBUTIONS TO OCEAN ENERGY SPATIAL PLANNING (presentation)

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The rapid increase in interest in and development of ocean-based renewable energy sources worldwide, along with technological advances that allow these installations to be placed further and further offshore, have sparked a number of efforts to map and model marine bird distributions in order to avoid conflicts between ocean energy installations and important bird areas. Here we present the results of an ongoing effort to synthesize and model all science-quality at-sea marine bird datasets available for the U.S. Atlantic coast, from the Straits of Florida to the northern Gulf of Maine, from nearshore to the 200 nautical mile U.S. Exclusive Economic Zone, and from the late 1970's to the present, for the purpose of making spatial predictions of seasonal long-term relative occurrence probability and relative abundance distributions of more than 40 species of marine birds of particular concern for non-governmental, state, and federal entities. We discuss how these models have been and are

anticipated to be used in a variety of marine spatial planning processes with a focus on siting and environmental assessment of offshore renewable ocean energy installations. We discuss specific examples of the role these models have played in planning processes and environmental assessments at the state, federal, and regional level, and consider additional roles that models may play in future planning processes. We also discuss the limitations of models and the importance of using multiple approaches to identify and confirm important bird areas, determine habitat usage, migration, and behavioral patterns, and anticipate changes; all important considerations in planning processes.

PACIFIC CLIMATE VARIATIONS AND THEIR IMPACTS ON CALIFORNIA CURRENT SYSTEM ECOSYSTEMS (plenary presentation)

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This talk focuses on climate driven seasonal to century scale variations in the California Current System (CCS), and how these variations are related to local, regional, and basin scale climate patterns (including ENSO, NPGO, PDO and the recently described *California El Nino*). Key regional patterns in winds, currents, and heat exchanges between the ocean and atmosphere that dominate variations and trends in CCS temperatures will be described. The major climate oscillations important to the NE Pacific will then be defined and their typical evolution described. I will also review the current state of knowledge linking environmental changes in the CCS with ecosystem impacts, including impacts on top predators like salmon and seabirds. The presentation will conclude with a short list of key questions about the potential impacts of anthropogenic climate change on the CCS and its marine life.

MODELING SEABIRD DISTRIBUTIONS FOR MARINE PLANNING BY WASHINGTON STATE (presentation)

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Marine birds are diverse, highly mobile species with high potential for interactions with human activities in coastal ecosystems. Habitat modeling can help to avoid and minimize adverse interactions by facilitating spatial planning. We developed seasonal distribution maps of seven seabird species off the Pacific Coast of Washington by integrating eight observation data sets and applying an ensemble machine-learning technique with component-wise boosting of

hierarchical zero-inflated count models. The compilation of federal, state and academic observation data offers exceptional spatial and temporal resolution of patterns across seasons and years. The modeling technique allowed for complex non-linear relationships between response and predictor variables and interacting effects among spatial and temporal predictors. This technique solved key statistical challenges associated with heterogeneous survey platforms across multiple data sets, spatially and temporally biased effort, and the aggregated nature of sightings. Output maps provide a starting point for evaluating risk to marine bird populations in the region from human activities and identifying important offshore seabird conservation sites.

EL NIÑO/LA NIÑA–SOUTHERN OSCILLATION OCEANOGRAPHIC VARIATION AND THE AT-SEA DISTRIBUTION AND FORAGING ECOLOGY OF PISCIVOROUS SEABIRDS IN THE OCEANIC EASTERN PACIFIC

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Negative effects of strong El Niño events on seabird foraging success have been established in numerous studies of breeding success and survival, particularly among coastal upwelling-associated seabirds. The influence of both positive and negative phases of El Niño–Southern Oscillation (ENSO) climatic and oceanographic variability on the distribution and foraging ecology of oceanic seabirds at sea, however, remains less substantiated. Using NOAA/NMFS transect surveys of seabirds and feeding flocks associated with subsurface predators (tunas and dolphins) in the eastern tropical Pacific, Hawaii, and California Current we begin to address this information gap through empirical characterizations of abundance and occurrence changes across a spectrum of ENSO states. Using anomaly maps generated by contrasting density surfaces estimated via generalized additive models, we found displacements of dolphin-associated seabird feeding flocks and associated seabirds away from the core of the eastern Pacific warm pool a during positive phase ENSO event. We also examined changes in community and flock composition across a range of oceanographic conditions related to ENSO states.

BEHAVIOR CHANGE: THE CORNERSTONE OF SEABIRD CONSERVATION (presentation)

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The Seabird Protection Network is implementing community-based social marketing practices in order to reduce human disturbance at a seabird breeding and roosting site along the

California coast. Communitybased social marketing involves 5-steps: 1) selecting behaviors, 2) identifying barriers and benefits, 3) developing strategies, 4) conducting a pilot, and 5) broad-scale implementation. This presentation will highlight the 5-steps of community-based social marketing, and share preliminary results and outcomes of the Network's new tool being used for seabird conservation. Since the Network began we have focused on a behavioral intensive approach, believing that if we can change attitudes we can change behaviors. Increased public awareness, coupled with coordinated management, enforcement and strategic partnerships has effectively minimized negative human interactions with seabirds. We have achieved many program successes; however, disturbance at one site continues to be a concern. Disturbance rates at Devil's Slide Rock monitoring site have fluctuated between 0.451 and 0.068 disturbances per observation hour from 2005 to 2014. Compared with the average 0.002 disturbances per observation hour at other monitoring sites, Devil's Slide Rock continues to be an area of concern. In November 2014, the Network began implementing community-based social marketing practices in an effort to reduce the overall rate of disturbance at Devil's Slide Rock and become more consistent with the other regional monitoring sites. Community-based social marketing strategies can be applied in numerous instances, and can produce behavior changes that support sustainability and conservation, world-wide.

OBSERVE A WILDLIFE DISTURBANCE? REPORT IT! (poster)

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Wildlife disturbance reports are a valuable tool for seabird conservation. In California, the Seabird Protection Network has developed an online system for reporting wildlife disturbance. By tracking wildlife disturbances, the Network is able to: 1) Assist natural resource managers with targeting outreach efforts; 2) Track repeat offenders; and 3) Target enforcement efforts. With increasing coastal human populations, disturbance to wildlife will likely continue to proliferate and impact seabird colonies and other marine wildlife along the California coast. Low-flying aircraft, close approaching watercraft and coastal visitors can disrupt breeding and roosting seabirds, which can lead to a reduction in the long-term population size and resiliency of the affected populations. Any activity that disrupts the natural behaviors of marine wildlife is a disturbance. The severity of a disturbance varies widely. A disturbance can be as simple as a seabird showing signs of agitation by head-bobbing and beginning to move away from its nest or roost site. Conversely, a disturbance can be as extreme as the loss of eggs or death of chicks or pups from trampling as the birds or marine mammals scatter away from the disturbance source. Tracking observed disturbance sources, severity, locations and species affected is important to understand the scope of this conservation issue. Chronicling wildlife disturbances provides a means to use adaptive outreach and management strategies to address conservation issues. The Seabird Protection Network works to address human disturbance to seabirds through coordinated outreach, monitoring and enforcement in California through a multi-organization collaborative.

HERE'S THE SCOOP ON SKUA POOP: THE REPRODUCTIVE SUCCESS AND DIETS OF SOUTH POLAR SKUAS BREEDING ON KING GEORGE ISLAND (poster)

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King George Island is located on the Antarctic Peninsula, an area that has recently experienced intense climate warming, large-scale changes in ice conditions, and declines in some krill-dependent predators, such as Adélie penguins. South Polar skuas (Stercorarius maccormicki) are piscivorous seabirds whose fledging success varied between 0.01 and 1.36 chicks per nest in the years 2004-2011. We hypothesized that, in years of low reproductive success, 1) average size of fish was smaller, 2) there were a greater frequency of small size classes of fish, and 3) skuas consumed a higher diversity of fish species. We tested whether these trends were more evident during courtship and incubation in years where hatching success was low. We collected guano samples of South Polar skua pairs during courtship, incubation, and chick rearing, from which we isolated and measured over 1000 otoliths. On the basis of these otoliths, we identified fish species and estimated fish sizes. We found that mean fish size varied significantly amongst years. Frequencies of size classes of fish also varied, and there appear to be identifiable cohorts within the fish populations. Fish diversity in skua diets was low; two species, Electrona antarctica and Pleurogramma antarcticum, dominated. We found no significant differences in diets among breeding phases.

BLACK-FOOTED ALBATROSSES HAVE HIGHER LEVELS OF INDIVIDUAL VARIABILITY IN BEHAVIOR AND DIET THAN THEIR SYMPATRICALLY-BREEDING CONGENER, THE LAYSAN ALBATROSS (presentation)

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Laysan and black-footed albatrosses breeding synchronously in the Northwestern Hawaiian Islands are morphometrically and functionally similar, and appear to avoid competition through distinct at-sea spatial segregation. However, this spatial segregation breaks down in the short but critical chick-brood phase when adults are limited to shorter foraging trips near the breeding colony while experiencing a substantial increase in energetic demands to feed their rapidly growing chick. The aim of our research was to examine fine-scale behavioral and dietary mechanisms shaping resource partitioning during the chickbrood when competition (both inter-

and intra- specific) is likely to be the fiercest. Here, we combine the results from two studies: a fine-scale behavioral study and a lipid analysis on albatross stomach oil. We used an individual-based analytical approach on both behavioral and dietary dimensions . GPS tracking data on 18 Laysan and 20 black-footed albatrosses revealed distinct behavioral partitioning between species, with Laysan albatrosses in an active forage mode 53% of the night and 39% of the day. The reverse was true for black-footed albatrosses: active forage mode made up 37% of night and 52% of day. Within-species partitioning was higher in black-footed albatrosses on both the behavioral and dietary dimensions, indicating that they may be under greater intra-specific competitive pressures. Laysan albatrosses showed less individual variability in behavior and diet, and behavioral partitioning within that species appears to be driven by size and sex. The contrasting structure of behavioral and diet variability in these two congeners suggests they may be experiencing different selective pressures.

SEABIRD AND CETACEAN ASSOCIATIONS WITH PREY, BATHYMETRY, AND HYDROGRAPHIC FEATURES IN NORTHWEST ATLANTIC SUBMARINE CANYONS DURING SUMMER 2010 (presentation)

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The northwest Atlantic shelfbreak is incised by numerous canyons, but few studies have examined predator-prey associations in these little-sampled canyon systems. Here we report our results of a short cruise off of the U.S. east coast in July of 2010 to document conditions likely to influence the distribution and abundance of seabirds, cetaceans, and potential prey in two submarine canyons (Atlantis and Veatch) and two adjacent non-canyon regions. We used the strip-transect method to quantify seabird and whale abundance, while potential prey (zooplankton and fish) were sampled with multi-frequency acoustics and net tows. The core seabird community, composed of Wilson's Storm-Petrels, Cory's and Audubon's Shearwaters, fed along a frontal zone between a Gulf Stream warm-core ring and a cold water entrainment off the shelf and were not strongly associated with canyons. Shearwater density had a tendency to increase with increasing strength of fish-like backscattering, whereas odontocete whales tended to aggregate in canyon heads and shallower regions characterized by deep patches of euphausiid-like scattering. Storm petrels were broadly distributed yet were densely aggregated in Veatch. The distribution and abundance of top predators may reflect their disparate foraging strategies (e.g., surface feeding vs. diving) used to exploit profitable prey patches in both vertical and horizontal dimensions. Ephemeral frontal zones and retentive features that serve to aggregate prey in these dimensions may function as important mechanisms to facilitate trophic transfer at shelfbreak and submarine canyons systems.

COMPARISON OF TREATY INDIAN AND NON-TREATY GILLNET FISHERY EFFORT AND MARBLED

MURRELET (*BRACHYRAMPHUS MARMORATUS*) POPULATION TREND DATA IN THE SOUTHERN SALISH SEA (presentation)

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In December 2011, a Geographic Information Systems (GIS) mapping project was initiated to determine a correlation between declining marbled murrelet population trends and increasing gillnet fishery landings in the southern Salish Sea within the boundaries of Washington State. In 2012, the GIS mapping project overlaid marbled murrelet population densities with Non-Treaty fisheries catch effort provided by the Washington State Department of Fish and Wildlife to examine seasonal variations in marbled murrelet foraging and fishing trends from 2001 to 2010. In 2013, Treaty-Indian fisheries catch effort was overlaid with marbled murrelet densities. Preliminary analysis showed catch effort for Treaty Indian Tribes has generally decreased or remained the same from 2001 to 2010 in areas with past high fishery catch effort orresponding with a high presence of marbled murrelets, with the exception of one catch area showing moderately high increases in fishing effort corresponding to high marbled murrelet presence. In marine catch areas with historically low fishery catch effort and low presence of marbled murrelet, fishery efforts have increased. When combined with Non-Treaty fisheries, results demonstrated that, overall, no correlation was found between declining population trends and increasing fishery landings. In areas of high marbled murrelet densities, lower fishing effort generally occurred; in areas of low marbled murrelet densities, higher fishing effort occurred. This information will assist Federal agencies in identifying areas of high risk for consideration in future Endangered Species Act Treaty-Indian and Non-Treaty fishery consultations to reduce the potential for future marbled murrelet fishery-related mortality.

MODELLING LONG-TERM AT-SEA DISTRIBUTIONS OF MARINE BIRDS IN THE MAIN HAWAIIAN ISLANDS TO INFORM SPATIAL PLANNING (presentation)

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The State of Hawai'i is aiming to derive 40% of its energy from renewable sources by 2030. To inform spatial planning and risk assessment for marine renewable energy, the U.S. Bureau of Ocean Energy Management has funded a marine Biogeographic Assessment of the Main Hawaiian Islands. Here we report on efforts to characterize the long-term at-sea distributions of marine birds as part of that assessment. We analyzed visual sightings data from U.S. National Oceanic and Atmospheric Administration ship surveys conducted in the Hawaiian Exclusive Economic Zone between 1998 and 2010. An ensemble machine-learning technique was used to model counts of each species as a function of multiple spatial and temporal environmental predictor variables while accounting for heterogeneous survey effort and the aggregated

nature of sightings. In particular, we examined the ability of long-term climatologies of dynamic environmental variables (e.g., frequency of occurrence, strength, and persistence of sea surface temperature and chlorophyll fronts) to explain spatial patterns of occurrence and abundance. Fitted models were used to predict the distributions of marine birds throughout the study area, and these maps provide essential information for marine spatial planning to minimize potential conflict between human activities such as renewable energy development and marine wildlife.

SEABIRD BYCATCH PATTERNS IN ALASKA: GOOD YEARS, BAD YEARS, AND PINK SALMON (presentation)

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(see pdf of ppt presentation)

FOOD WEB LINKS BETWEEN SEABIRDS AND PELAGIC SCHOOLING FISHES IN THE ESTUARY, PLUME, AND NEARSHORE MARINE HABITATS OF THE COLUMBIA RIVER (presentation)

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Hundreds of thousands of seabirds aggregate in the Columbia River estuary and adjacent coastal regions during April to September. We synthesized existing studies to better understand marine food sources supporting seabirds near the Columbia River. Birds are numerically dominated by common murres (Uria aalge), sooty shearwaters (Puffinus griseus), double-crested cormorants (Phalacrocorax auritus), Brown pelicans (Pelecanus occidentalis), gulls (Larus spp.), and Caspian terns (Hydroprogne caspia), but also include loons, Western grebes, and less common cormorants, alcids, and procellarids. Large tidal exchanges between the Columbia River and nearshore ocean are accompanied by large but poorly understood changes in the distribution and biomass of marine schooling fishes. ESA-listed juvenile salmon (Oncorhynchus spp.)and eulachon (Thaleicthys pacificus) also occupy the same habitat. Data suggest that northern anchovy (Engraulis mordax), whitebait smelt (Allosmerus elongates), Pacific herring (Clupea pallasi), and juvenile salmon are the key pelagic prey supporting seabirds in this region. Three fish species are common to both estuary and ocean: northern anchovy, surf smelt, and Pacific herring; juvenile salmon (primarily O. tshawytscha, O. kisutch, and O. mykiss) are also common in both locations.

In contrast, juvenile American shad (Alosa sapidissima) are numerically dominant in the estuary only, whereas whitebait smelt, Pacific sardine (Sardinops sagax), and juvenile Pacific hake (Merluccius productus) are numerically common only in the ocean. Interactions among seabirds, pelagic fishes, and ESA-listed anadromous fishes have a number of implications for future management and conservation of marine resources.