FIRST WORLD SEABIRD CONFERENCE

September 7-11, 2010, Victoria, British Columbia

NOAA FISHERIES

STAFF AND/OR CONTRACTORS

Submitted Abstracts for Presentations and Posters

Nacho Vilchis and Lisa Ballance (SWFSC)
Analysis of long-term trophic level shifts in a tropical seabird community

"Understanding mechanisms driving past ecosystem changes are of paramount importance for the interpretation of contemporary environmental change and ecosystem response. With this mindset, we set out to gauge effects of the 1976-77 regime shift of the Pacific Ocean in a tropical and pelagic community of apex predators. Using study skins of historical specimens from museum collections, we retrospectively (1960-2006) measured stable carbon (δ13C) and nitrogen (δ15N) isotopes for a suite of ecologically and phyolgenetically diverse seabirds from the eastern Pacific warm pool. In this region, seabirds generally forage by depending on subsurface predators to drive prey to the surface or by associating with oceanographic features that increase productivity or aggregate prey in space or time. We found no community wide changes in response to the 1976-77 regime shift. Instead we found evidence suggesting a trophic shift and or change in foraging area for Sooty Terns and a longterm decrease in feather δ13C for the eastern Pacific warm pool seabird community. This long-term decrease in feather δ13C can be accounted for by the Suess effect and not a decline in primary productivity of the system. We hypothesize that a deepening trend in thermocline depth in the eastern Pacific warm pool is affecting Sooty Terns more so than other species in the subsurface predator-dependent guild which depend less on smaller subsurface predators like skipjack tuna." (V1-10 presentation)

Nadav Nur and Jaime Jahncke; Mark Herzog; Julie Howar; K. David Hyrenbach; David Ainley; John Wiens; Lisa Ballance (SWFSC); Kenneth Morgan; Jen Zamon (NWFSC); Diana Stralberg
Seabird hotspots in the California Current System: implications for marine spatial planning

"We developed predictive models of seabird distribution to identify areas that support foraging aggregations ("hotspots") to inform marine spatial planning and designation of marine protected areas in the California Current System (CCS). We hypothesized that seabirds aggregate in predictable areas determined by bathymetric and oceanographic features. We modeled 16 species using at-sea observations collected between 1997 and 2008 in an area extending from Vancouver Island to the US/Mexico border and up to 600 km offshore. Single-species predictive models included bathymetric variables (e.g., depth; proximity to continental shelf-break) and remotely sensed oceanographic covariates (e.g., chlorophyll-a). Bathymetric variables were often strong predictors; oceanographic variables were less important. Model predictions were applied to the CCS for each season in each of 11 years. Single-species predictions were combined to identify potential hotspots using three criteria: (1) overall abundance, (2) importance of "core areas", and (3) predicted persistence. Predicted hotspots were often aligned with currently protected areas, but we also identified potential hotspots in Northern California/Southern Oregon and off Vancouver Island that may warrant additional protection.
Modeling seabird aggregations provides a powerful tool to identify marine hotspots and,

when combined with information on specific threats and economic constraints, can assist marine spatial planning at a broad scale." (V6-2 presentation)

David Ainley and Eric Woehler; Christine Ribic; Lisa Ballance (SWFSC)
Pelagic studies: Advances in the at-sea studies of seabirds
"Understanding the ecology of seabirds means understanding their role in marine ecosystems, enabling prediction of population responses to biophysical changes in the marine environment. The 'classical' age of at-sea investigation of seabirds occurred during the 1970-90s, a time when extensive data usually from "platforms of opportunity" were collected. Much was learned about seabird associations with specific water masses, in addition to close associations with gyres, eddies and frontal zones from large- to meso- to local-scales. These correlations of population variability with physical features helped researchers to formulate questions about processes at different temporal and spatial scales that might drive the patterns. Advancing these subjects was the standardization of data collection and data analyses, in conjunction with the advent of remotely sensed information on ocean productivity as well as the inclusion of seabirds as bona fide components of research cruises. Most recently, the development of predictive quantitative models integrating seabird occurrence patterns to ocean productivity and its proxies have guided the discipline. With the most recent advances in technology, we are poised to understand the biophysical mechanisms by which changes occur in seabird populations; in order to do this, seabirds and their co-occurring species need to be fully integrated into designed multidisciplinary oceanographic ecosystem investigations, particularly at the meso-scale. Taking an ecosystem-view of seabirds, rather than a species-centric view, will be important in light of large-scale ecosystem changes already underway and we propose several avenues of research to provide new insights into this "seabirds as a part of marine ecosystems" view." (V11-6 presentation)

Sage Tezak (NOS, contractor), and Karen Reyna (NOS); Mai Maheigan; Gerard McChesney;
Jennifer Boyce (SWR)
Using Marine Protected Areas to achieve restoration of seabird colonies: A case study on the Central California coast
"This presentation will discuss ways to successfully promote change in human behavior by focusing on a comprehensive approach to protect seabirds. High levels of human disturbance, including frequent interruptions of natural behaviors or a single severe event, can impact breeding and roosting seabird species. This case study will explore the successes of the Seabird Protection Network (Network), a multi-organization collaborative, developed to address human disturbance to seabird colonies, in a region with the largest concentration of seabirds in the contiguous United States, central California. The three primary components of the Network are: 1) Outreach; 2) Enforcement and Coordinated Management; and 3) Monitoring. The most frequent human caused disturbances to seabirds in California fall into three categories: close approaches by motorized and non-motorized boats; low-flying aircraft; and hikers accessing near-shore colonies from land. A network of protected areas has been established near key seabird colonies, including no-access zones in the water surrounding colonies, the protection of offshore sea stacks making up colony sites, and the airspace above colonies. Establishing no-access marine protected areas to protect seabirds at breeding colonies can be controversial, affecting both consumptive and non-consumptive ocean users. An important aspect of building constituency includes fostering and maintaining support through a comprehensive outreach program that: 1) effectively targets individuals and/or groups impacting the resource; 2) builds awareness; and 3) promotes stewardship. However, outreach and education cannot prevent all sources of human disturbances, which is why marine protected areas that can be enforced, is critical." (P1-145 poster)

Jennifer Boyce (SWR) and Laurie Harvey; Annie Little; Laird Henkel
Montrose Settlements Restoration Program -

restoring seabird populations on the Channel Islands of California, United States"
"From the late 1940s to the early 1970s, millions of pounds of DDTs and PCBs were discharged into ocean waters off the Southern California coast. Almost all of the DDTs originated from the Montrose Chemical Corporation's manufacturing plant in Torrance, California, and were discharged into the Los Angeles County Sanitation Districts' wastewater collection system. The DDT-contaminated wastewater was discharged into a submarine area known as the Palos Verdes Shelf. Additionally; large quantities of PCBs (polychlorinated biphenyls) from numerous sources throughout the Los Angeles basin were also released into ocean waters. As required by Superfund law, the Montrose Trustee Council must use settlement funds to restore natural resources harmed by the DDTs and PCBs. Seabird restoration is one four restoration categories the Trustee Council has identified for restoration within the Southern California Bight. The Trustees selected seabird restoration actions that benefit species with evidence of injuries from DDTs or with past evidence of elevated levels of DDTs in their eggs. Starting in 2006, the program has been implementing several seabird restoration projects to benefit seabird populations nesting on the Channel Islands. These projects include: Restoring Seabirds to Scorpion Rock and Orizaba Rocks off Santa Cruz Island, Restoring Alcids to Santa Barbara Island, and San Nicolas Island Seabird Restoration. The goal of these projects is to restore populations of Xantus's Murrelets , Ashy Stormpetrels, Cassin's Auklets, Brandt's Cormorants and Western Gulls using a combination of habitat improvement, social attraction, and introduced predator removal." (P2-41 poster)

Jennifer Boyce (SWR) and Steve Hampton; Laird Henkel; Matthew Zafonte
Seabird restoration to compensate for oil spills in California
"In California, nine coastal oil spills and one DDT contamination site have impacted nearly 100,000 birds since 1990. Under state and federal laws, certain government agencies are designated as trustees for natural resources and may seek damages or restoration to compensate for injuries to wildlife and habitat in the event of an oil spill or other pollution event. These trustees have recovered over $55 million to implement seabird restoration projects to compensate for injuries to seabirds. These projects have included murre colony restoration; rat eradication on Anacapa Island; cat removal on San Nicolas Island; habitat restoration on the Channel Islands, Ano Nuevo Island, and Southeast Farallon Island; raven management and land acquisition for Marbled Murrelets; pelican roost site protection; and grebe colony protection. While most of the projects have been in California, the trustees have also implemented projects in Mexico, Canada, Alaska, and New Zealand to benefit birds killed in oil spills off California's coast. This poster describes the natural resource damage assessment (NRDA) process with respect to seabirds. It summarizes past oil spill impacts and describes the injury assessment and restoration scaling process, including mortality estimation and the use of Resource Equivalency Analysis (REA) to calculate the size of a bird restoration project necessary to compensate for a mortality event." (P2-43 poster)

Joan Browder (SEFSC) and Andreas Winter; Yan Jiao
Modeling low rates of seabird bycatch in the U.S. Atlantic longline fishery
"Incidental capture of seabirds in commercial fisheries is a worldwide issue of concern for potential damage to vulnerable populations and their ecosystems. NMFS SEFSC initiated a project in 2004 to improve seabird bycatch estimation in the U.S. Atlantic pelagic longline fishery. The project's first component was training in the Pelagic Observer Program to improve the specificity and accuracy of seabird identification. The most recent component is development of a new analytical approach to improve estimation of the total annual seabird bycatch of the fleet based on observer data. Catch, bycatch, effort, and other information are reported on observed longline trips. Estimates of total annual seabird bycatch are extrapolated from observed trips to the entire fleet based on total effort. The infrequency of seabird bycatch in observed longline sets (0 to 33 birds per year

from 1992 to 2008 in ~5500-17300 observed sets) and low proportions of sets observed (2-7% from 1992 to 2005 and 10-14% from 2006 to 2008), raised concerns about reliability of estimates, leading to this work. We examined alternate methods of estimating seabird bycatch using generalized additive models (GAM), generalized linear models (GLM), and GLM with spatially auto-correlated parameters. Models were applied separately to probability of seabird bycatch (presence/absence) and numbers of seabirds per positive bycatch; then multiplied. AIC suggested best-fitting models included latitude, longitude, and quarter of year for presence/absence and numbers of hooks per set for positive bycatch. A composite model of GAM (presence/absence) and GLM (positive catch) gave best predictions of total seabird bycatch." (P2-4 poster)

Kimberly Dietrich (AFSC, contractor) and Shannon Fitzgerald (AFSC)
Seabird bycatch in Alaska trawl fisheries: A comparison of observer sampling protocols
"Seabird bycatch in commercial fisheries, especially longline, trawl and gillnet fisheries, is recognized as a global conservation problem. In some southern hemisphere fisheries the bycatch of certain albatross species has been identified as the cause for serious population declines. North Pacific Groundfish Observers conduct species composition sampling on trawlers to support estimation of total removals for a variety of species. Sampling protocols work well in support of estimates of mortality for most fish species. Unfortunately, the estimates of seabird mortalities associated with trawl fishing operations are likely biased as seabird mortalities may also occur from encounters with rigging (trawl sonar and trawl door cables) or the net forward of the codend. Current sampling protocols are not able to account for either of these situations. Observers have been collecting data on seabird interactions with trawl warps, nets, and third wires over several years as part of a special project assigned to prior, experienced observers only. We compare seabird bycatch based on current observer protocols with the number of birds caught using the specialized observation protocols. Initial summaries reinforce the hypothesis that current estimates are low. We review changes incorporated into standard operating procedures for observers as a result of this work and recommend methods to improve seabird monitoring on trawlers in Alaska." (P2-1 poster)

Ed Melvin and Kimberly Dietrich (AFSC, contractor); Shannon Fitzgerald (AFSC); Tamre Cordoza
Reducing seabird strikes with trawl cables in the Pollock Catcher-Processor Fleet in the Eastern Bering Sea
"Little is known about threats posed to seabirds by cable strikes in northern hemisphere trawl fisheries or what mitigation measures might reduce those threats. We compared the rate of heavy seabird strikes with third-wire (scanning trawl sonar) cables and warps, using three mitigation measures, third-wire snatch block, streamer lines, and warp booms, compared to a control of no deterrent aboard two catcher-processor vessels targeting pollock in the eastern Bering Sea (EBS), one that rendered the majority of the offal and bycatch into fish meal and fish oil and one that discharged macerated offal. More birds attended the non-meal vessel, but the rate of seabird cable strikes was higher for the meal-vessel, due to the greater aerial extent of its cables. Streamer lines significantly reduced heavy seabird strikes with both cable types by at least an order of magnitude regardless of the discharge type. Reducing the aerial extent of third-wires also reduced third-wire strike rates, but was less effective than streamer lines. Warp booms designed to divert seabirds from warps failed to significantly reduce seabird warp strikes, but this technique can be improved. Collectively these results show for the first time that seabird strikes with 'modern' third-wire trawl sonar cable systems can be reduced through gear modification and that warp strikes can be mitigated with techniques similar those in place in southern hemisphere fisheries. However, because only small-winged birds classified as of least conservation concern were struck and appeared unharmed the need for mitigation in the EBS pollock fishery is questioned." (P2-2 poster)

Ann Edwards (AFSC, contractor) and Shannon Fitzgerald (AFSC); Julia Parrish
Variable foraging strategies of Laysan Albatross in relation to ecosystem change and fisheries overlap
"Stable isotope data indicate that a fundamental shift in foraging dynamics has occurred among Laysan Albatross (*Phoebastria immutabilis*) over the last 100 years. Discards from offshore fishing operations have introduced a novel food source, further contributing to long-term shifts in foraging dynamics. What are the limits of foraging flexibility in light of ecosystem change, and how do foraging limits and requirements affect overlap with fisheries? We used Δ15N values from targeted primary feathers (grown May – Oct) as indices of foraging strategy. Two patterns emerged. The 'recovery and maintenance period' following the end of the breeding season (approximately May – July) was marked by a great diversity of foraging strategies, both historically (Δ15N range: 8-18Δ) and recently (11-19Δ). The absence of low values today (33% of historic values were below today's observed values) suggests resiliency to the loss of foraging opportunities during this flexible May-July foraging period. Isotope values of fisheries-associated birds in Alaska were distinct from other birds during this flexible season, but not at other times, suggesting season-specific flexibility facilitates overlap with distant fisheries. In contrast, the 'preparation period', or the period prior to arrival at the breeding colony (approximately Aug – Oct), was more conservative for all birds, marked by foraging strategies that were less variable, with current mean values indistinguishable from historical values. Consequently, the more conservative foraging requirements of Laysan Albatross prior to breeding may limit their ability to adapt to ecosystem change, but also may reduce their potentially fatal overlap with Alaskan fisheries." (C12-4 presentation)

Shannon Fitzgerald (AFSC) and William Walker (AFSC)
The use of fisheries bycaught marine birds in investigations of natural feeding strategy
"National Marine Fisheries Service (NOAA Fisheries) certified fisheries observers deployed to commercial fishing vessels have been collecting marine bird carcasses periodically from 2000-2009. Observers have returned well over 400 marine birds from these fisheries, which include the Hawaiian pelagic longline fisheries and the Alaskan groundfish trawl and demersal longline fisheries. Marine birds were necropsied and stomachs were examined. The stomach contents of three species of marine birds were analyzed for this study, including 180 Northern Fulmars (*Fulmaris glacialis*), 40 Laysan Albatross (*Phoebastria immutabilis*), and 25 Black-footed Albatross (*P. nigripes*). The preliminary results from this study revealed that commercial fisheries-related food items such as bait and discarded catch remains (offal) were readily separable from the remains of naturally occurring prey. Though the dietary composition of the birds is undoubtedly altered by the concentration of available food generated by fisheries activities, the large sample size of birds examined and the incidence of naturally occurring prey items provide valuable information about feeding strategies in the absence of fisheries and will help guide future collections and analysis." (P1-67 poster)

Tom Good (NWFSC) and Amanda Phillips (NWFSC)
Marine debris entanglement of seabirds: global patterns, impacts, and solutions
"Marine debris affects seabirds via ingestion of anthropogenic materials (e.g., plastics, pellets, fish hooks, etc.) and entanglement in derelict fishing gear (recreational or commercial fishing nets, lines, etc.) and other entangling plastic debris lost or abandoned in the marine environment. A 2009 report of the United Nations Food and Agriculture Organization and Environment Programme reported that approximately 640,000 tons of discarded fishing gear enters the oceans yearly, accounting for nearly 10% of the world total of marine debris. Since the 1950s, most of the world's fishing industries replaced nets composed of natural fiber with those made from synthetic material, resulting in lost or abandoned fishing gear remaining in the marine environment for decades. Derelict fishing gear has been implicated in the entanglement and death of marine birds since the 1970s, and entanglement

and ingestion impacts were reviewed in the 1990s. Since then, there has been an increase in gear retrieval programs and explicit studies on the fate and biological impacts of derelict gear, including impacts on marine birds. We reviewed published and unpublished reports of seabird entanglement and mortality to summarize geographical, taxonomic, and fishery patterns worldwide. Monofilament line is the most common entangling gear, with monofilament gillnets causing the greatest mortality. Over 80 species of marine birds have been documented entangled; however the demographic effects of this mortality source are not well understood. United Nations resolutions now require reducing derelict fishing gear and marine debris in general, and clean up efforts underway worldwide should reduce associated risk for all seabirds." (V3-1 presentation)

Annette Henry (SFWSC) and Lisa Ballance (SWFSC); Thomas Moore (SWFSC, contractor); Christopher Cutler; Michael Force; Rich Pagen; Sophia Webb
Quantifying Marine Debris in the Eastern Tropical Pacific Ocean
"As part of the 2006 Stenella Abundance Research (STAR) survey, two seabird observers were placed aboard each of two NOAA research vessels to collect data on the distribution and abundance of marine debris, concurrently with data on seabirds. The survey area was the eastern tropical Pacific (ETP) and included 12 countries, the high seas, and three major surface currents. NOAA Ship David Starr Jordan surveyed primarily the shelf and nearshore areas while NOAA Ship McArthur II focused on the high seas. Using strip transect methods, a total of 2,177 sightings of marine debris were made: 1,547 from the Jordan and 630 from the McArthur II. Marine debris sightings were classified into 10 categories: glass; metal; monofilament line, ropes and fishing gear; organic matter; paper or cloth; plastic; rubber; Styrofoam; wood; and "other" which consisted of unidentifiable or multiple items of different categories. More than 95% of the marine debris encountered could be described in four categories: plastic, Styrofoam, wood and other. Plastic was the most common debris item sighted and accounted for more than half of all debris encountered (Jordan: 57.5%; McArthur II: 64.4%). We found that the density of marine debris in the ETP varied spatially and was relatively high in shelf or nearshore waters of most countries as well as in convergence zones such as the Equatorial Front." (V3-11 presentation)

Jefferson Hinke (SWFSC) and Wayne Trivelpiece (SWFSC)
Rapid climate change and life history: How plastic is the Adélie Penguin?
"Climate change is having major impacts on physical and biological systems in the Antarctic. For Adélie penguins, different populations have been subject to different environmental conditions over space and time. To assess the ability of Adélie penguins to cope with rapid climate change, we compare survivorship, fecundity, age at first breeding, chick growth, and breeding success from long-term monitoring studies conducted within the last 5 decades throughout the latitudinal range of Adélie penguins. Results suggest that Adélie penguins retain inflexible life history traits associated with fecundity and chick rearing in all areas, but exhibit strong spatial variability in survival rates and the age of first breeding. These results demonstrate that Adélie populations do respond to local climate change in a manner consistent with life history theory, which predicts a trade-off between survival rate and the age of first breeding. However, the observed responses have been insufficient to maintain positive population growth rates in the Antarctic Peninsula region. Here, the rapid rate of climate change appears to have exhausted the ability of Adélie penguins to persist in natal habitats. " (P2-21 poster)

Nicole LeBoeuf (IA) and Rebecca Lent (IA)
Interactions between seabirds and fisheries: a global perspective
"Seabirds, particularly albatrosses and petrels, are taken as bycatch in longline fisheries worldwide. Although actual estimates can be lacking or imprecise, estimates of seabirds killed annually in fisheries worldwide run in the hundreds of thousands. For some species, interactions with fisheries are among the most serious of threats to their long-term conservation. While an individual fishing vessel

may catch a seabird only occasionally, the scale of global fishing may threaten a species' very existence. A decade ago, global longline fisheries were estimated at approximately 1.4 billion hooks annually, the equivalent of 3.8 million hooks each day. Today, this number may be higher as longline fisheries have expanded worldwide, both in terms of vessels and overall effort. Because seabirds' movements cross geographic boundaries and those of distant water fishing operations, any one country's efforts to reduce seabird bycatch alone will not solve the problem. Fortunately, the world's fishing nations have become increasingly aware of this issue and are responding in more and more coordinated ways. In particular, Regional Fisheries Management Organizations (RFMOs) whose longline fisheries overlap with seabird distribution are working together to address the problem. In June, the United States co-hosted a workshop of the five tuna RFMOs to address all bycatch in longline fisheries. Seabird bycatch was a primary issue at the workshop, not only for the successes that have been achieved to date, but for the steps that the RFMOs identified as needed for improving the efficiency and effectiveness of their efforts to reduce seabird bycatch in the future." (V8-4 presentation)

Jason Link (NEFSC) and Megan Tyrrell; Hassan Moustahfid (NOS/ASTADM)
The importance of including predation mortality in the evaluation and management of forage fishes
"Forage fish such as herring and mackerel are affected by a broad range of predators including piscivorous fishes, marine mammals, and seabirds. Accounting for predation mortality is an important consideration in ecosystem-based fisheries management and is especially important when setting management targets for forage fish populations. A suite of applications utilizing various fisheries models have demonstrated that predation mortality is: 1) ontogenetically variable, 2) temporally variable, 3) ergo not typically fixed at 0.2 as is commonly assumed, and 4) for forage species, generally higher than assumed in traditional single species stock assessments. Here we demonstrate that biological reference points (fishing mortality rates) generated by explicitly incorporating predation mortality into population dynamic models are generally more conservative than those produced using traditional fisheries assessment methods. Even if predation mortality is not directly included in such models, our results suggest assessments for forage fisheries should be more conservative. Because biological reference points are the benchmark against which fisheries management decisions are made, they should reflect the ecological realities faced by each species to the fullest extent possible. Adhering to the more conservative biological reference points produced by explicitly incorporating predation mortality is an easily implemented facet of ecosystem-based fisheries management." (V2-5 presentation)

Kristin Mabry (AKR) and Rob Suryan; Gregory Balogh; Kim Rivera (AKR)
Spatial planning to minimize fisheries and seabirds interactions in Alaska waters
"During 2007-2009, NOAA Fisheries Alaska region completed several analyses of satellite-tracking data depicting marine habitat use of the endangered short-tailed albatrosses and the distribution of hook-and-line fisheries' effort in Alaska's exclusive economic zone. These analyses were integral in two National Environmental Policy Act Environmental Assessments of revisions to seabird avoidance measures used in the hook-and-line fisheries. Analysts concluded that the requirement of using seabird avoidance measures in a portion of the Bering Sea and most of the inside waters of southeast Alaska were unnecessary due to limited use of this area by seabirds of conservation concern and due, in particular, to a low probability of fishing vessels encountering short-tailed albatrosses. Conversely, the requirement to use seabird avoidance measures in several transition zones and areas of more frequent usage by shorttailed albatrosses was considered necessary to decrease the risk of incidental take. Also, performance standards were specified for the use of avoidance gear in areas where interactions are more likely to occur. These changes were intended to relieve an unnecessary regulatory burden on fisheries that do not need seabird avoidance measures and to improve the effectiveness of avoidance measures in the fisheries that do."

Elizabeth Phillips (NWFSC, contractor) and Jeannette Zamon (NWFSC); Josh Adams; David Hyrenbach; Peter Hodum; Lauren Reinalda (NWFSC, contractor)
Anomalous Pink-footed Shearwater abundances in Oregon and Washington coastal waters: an ecosystem indicator in the northern California Current
"At-sea ecological surveys of the Oregon and Washington shelf waters reveal increased abundances of Pink-footed Shearwaters (Puffinus creatopus) in May and June of 2009 compared with prior survey years. Although this species occurred regularly in low numbers during previous survey years between 2003-2008, we suggest that a four-fold increase in 2009 is indicative of significant changes in surface ocean conditions within the northern California Current. Because Pink-footed Shearwaters are associated with warm ocean conditions in the California Current Ecosystem, we examined shearwater abundance compared to surface temperature, nutrients, chl-a, zooplankton, and fish species composition and abundance for evidence of warming effects on surface ocean communities. For example, the presence of fishes such as Pacific saury (*Cololabis saira*) and juvenile sablefish (Anoplopoma fimbria) may relate to increases in surface warming and/or offshore-to-inshore transport of water masses. We also examine newly available satellite telemetry data within our survey region from two Pink-footed Shearwaters tagged off southern California in the spring of 2009. These results highlight the value of marine bird surveys as upper trophic-level indicators of changing ocean conditions in the northern California Current." (C2-4 presentation)

Elizabeth Phillips (NWFSC, contractor) and Hannahrose Nevins; Diana Humple
A comparison of methods for age estimation of seabirds
"To characterize population-level impacts of seabird mortality from fisheries bycatch, oil spills, and periodic die-offs, an accurate estimate of the demographic composition of birds affected is paramount. Seabird age and sex ratios are useful for summarizing disproportionate mortality in a group of birds (e.g., adults) and can direct further research towards elucidating reasons for the mortality and possible mitigation measures. Several indices are used to estimate approximate age in dead seabirds, including maturity of the gonads (length and width of gonad in both sexes, diameter of largest follicle and oviduct development in females), size and description of the bursa of Fabricius, plumage, molt limits, active molt of primary and body feathers, ossification of the supraorbital ridge and, in rare cases, band returns. We review and compare methods used to estimate age in seabirds examined (n > 1000) at California Department of Fish and Game, Marine Wildlife Veterinary Care and Research Center, Santa Cruz, California, USA, and compare results among methods and species. A careful examination of all possible ageing variables will improve estimates of demographic impacts of mortality on seabird populations." (P1-174 poster)

Lauren Reinalda (NWFSC, contractor) and Jeannette Zamon (NWFSC); Elizabeth Phillips (NWFSC, contractor)
The use of digital imagery to improve training, accuracy, and efficiency in seabird diet analysis
"Seabird diet analysis frequently requires identification of bones and other hard parts to classify prey remains. Learning bone identification can be time consuming and overwhelming if one has no prior experience. The use of published keys and guides is helpful; however these resources are frequently limited to the identification of otoliths and large head bones. The use of a dissecting microscope with an attached digital camera allows observers to manipulate magnification and lighting to highlight bone features which are otherwise difficult or impossible to see directly through an objective. As a result, in addition to any otoliths or head bones that are present, smaller, non-standard diagnostic bones can now be used to provide a more complete picture of diet composition. Digital imaging also speeds up training and quality control by allowing multiple observers to view the same image and observers can compare bones from multiple samples without physically mixing the specimens. Digital images also facilitate sharing of

specimens with others who are not on site. Results show the combined use of digital imaging and non-standard diagnostic bones improves the accuracy of diet analysis (e.g. prey type, minimum prey number), especially for diet samples obtained with non-lethal methods such as regurgitation or lavage. Compilation of a digital image database for common prey types may be a useful research tool for seabird biologists." (P2-95 poster)

Jeannette Zamon (NWFSC) and Elizabeth Phillips (NWFSC, contractor); Lauren Reinalda (NWFSC, contractor)
Spatial and temporal structure of marine predator-prey interactions in the Columbia River plume
"During 2003-2009, May and June oceanographic surveys on the Oregon and Washington coasts (USA) revealed anomalously high concentrations of fish-eating birds near the mouth of the Columbia River. Further ship- and land-based investigation demonstrated associations between marine birds and the tidally-driven convergence fronts separating low salinity(< 20), recent river discharge from higher-salinity (27-31) coastal waters. Mixed-species aggregations include both surface-feeding and diving species (e.g. gulls, pelicans, alcids, shearwaters). Aggregations were evident and recurring at fine spatial and temporal scales of meters to kilometers and hours to days. Diet items from birds captured in these areas included planktivorous forage fishes such as northern anchovy, smelt, and herring as well as juvenile salmon. Preliminary evidence from hydroacoustic surveys shows fish schools primarily below the pycnocline, suggesting salinity structure has a strong effect on spatial distribution of forage fishes. We hypothesize the tidal dynamics of the Columbia River discharge create predictable aggregations of forage fishes in time and space, and fish aggregations then attract upper trophic level predators such as marine birds to river plume habitat. We propose the tidal dynamics of river plumes may be a general structural mechanism affecting predator-prey interactions in locations where river discharge affects coastal habitat." (P2-33 poster)

Marie Martin and Gina Shield (NEFSC)
Greater Shearwaters in the gulf of Maine and Georges Bank (Northwest Atlantic): Can we identify seabird foraging hotspots using at-sea and bycatch data?
"Greater shearwaters (*Puffinus gravis*) have been little studied due to their remote nesting locations and pelagic distribution at sea. They complete extensive annual migrations between their southern nesting grounds at Tristan da Cunha and the North Atlantic's productive waters. During these migrations, birds may interact with fisheries of approximatively 30 countries; However, the degree of interaction and incidental mortality is largely unknow in most waters. In the United States, greater shearwaters have been regularly documented as incidental bycatch in its Northeast gillnet fisheries since 1991. Utilizing 19 years of bycatch data and 7 years of at-sea distribution data, we investigate some of the species foraging hotspots and important use areas in the Gulf of Maine and Georges Bank. Additionally, we present some of the first data on condition, sex and age bias in bycaught greater shearwaters through necropsy examination of 135 specimens from the Northwest Atlantic between 2008 and 2009." (P1-109 poster)

Kathy Kuletz and Patrick Ressler; Elizabeth Labunski; Mike Sigler (AFSC); Martin Renner; Anne Hollowed (AFSC)
Using broadscale distributions of murres, kittiwakes, and their prey on the Bering Sea Shelf to inform decisions on MPA's
"Ecosystem management and designation of marine protected areas (MPAs) require an understanding of predator-prey dynamics at a broad scale. In Alaska, the Bering Sea outer shelf and slope is a 'hotspot' for seabirds and fish. Here, we examined distributions of surface-feeding Black-legged Kittiwake (*Rissa tridactyla*) and pursuit-diving Thick-billed Murre (*Uria lomvia*) in relation to two key prey, age-1 Walleye Pollock (*Theragra halcogramma*) and euphausiids. We conducted concurrent surveys of birds and prey from 66-m vessels, following a systematic shelf-wide grid (covering 411,494 km2) in June and July of 2007-2009. Strip-transect coverage for seabirds was ~ 9,000 km/year, and acoustic sampling of prey was ~15,000 km/year. Both bird species showed

colony effects, with high densities <300 km of St. Matthew and the Pribilof islands. Kittiwakes were more dispersed with greater inter-annual variability in distribution than murres. Murre densities were consistently highest between the Pribilof Islands and the underwater Pribilof Canyon. Though non-significant, murre distribution matched best with euphausiids while the kittiwake's matched best with pollock. Unlike murres, the variation in kittiwake distribution suggests they were sensitive to shifts in pollock distribution, which will make it difficult to define MPAs; possibly the case for all wide-ranging, aerial foragers. The distribution of juvenile pollock and euphausiids may be too unpredictable to assist in structuring MPAs for seabirds on the shelf. Rather, habitat features (i.e., Pribilof Canyon) can be identified, and thereby focus management actions." (C10-10 presentation)

Sue Trivelpiece (SWFSC, contractor) and Michael Polito; Wayne Trivelpiece (SWFSC)
Population dynamics and breeding biology of the Southern Giant Petrel (Macronectes giganteus) along the western shores of Admiralty Bay (ASPA 128), King George Island, Antarctica, 1980-2000
"We have been following and banding a population of southern giant petrels (*Macronectes giganteus*) nesting in nine small colonies at our research site on King George Island, South Shetland Islands, Antarctica since 1980/81. Reproductive success varied, but the overall mean was 0.72 (▪ } 0.16) chicks fledged per nest, which is consistent with other studies. Southern giant petrels will often take sabbatical leaves of one to two years between breeding efforts, which we found to affect nest-site fidelity versus birds that breed annually. We also examined demographic variables such as breeding success in relation to age & experience, cohort return rates, age at first breeding, & natal philopatry, and compared these with other studies. Our long term population data show†that the population in our region increased by 69% over this period, although it was stable throughout most of the 1980s. Several studies have also seen population increases for the same time period in other regions (e.g., Frazier Islands, Bird Island, Falkland Islands), although a recent analysis of the entire Southern Ocean population reported a marked decrease. We examine these opposing trends and how they may possibly be linked to such factors as climate change and human disturbance." (P1-131 poster)

Wayne Trivelpiece (SWFSC) and Jefferson Hinke (SWFSC); Aileen Miller; Christian Reiss (SWFSC); Susan Trivelpiece (SWFSC, contractor); George Watters (SWFSC)
Penguins in peril: an old ecological hypothesis replaces a current paradigm and links climate change to penguin population declines in the Western Antarctic Peninsula†
"The Western Antarctic Peninsula (WAP) encompasses some of the richest waters and most abundant wildlife populations on earth, some of which were nearly extirpated by the late 1900s. The WAP is also warming faster than elsewhere in Antarctica, and possibly on earth, with 5-6° C increases in mean winter temperatures and associated decreases in winter sea-ice extent and duration. These changing conditions have profoundly affected the ecosystem. A current paradigm guiding ecological interpretations of change in the WAP, the "Sea-Ice Hypothesis", suggests that less winter sea ice has directly led to population declines in "ice-loving" Adélie penguins, while "ice-avoiding" chinstrap penguins have increased. However, 30 years of field studies in the WAP and recent surveys throughout the Scotia Sea refute this hypothesis; both Adélie and chinstrap penguin populations have declined by >50% throughout this region. Furthermore, since these penguins were never harvested by man, changes in their populations track historical changes to this ecosystem. Here we present evidence supporting an older, more robust, hypothesis that explains both increases and decreases in penguin populations as a result of changes in the abundance of their main prey, Antarctic krill. Linking trends in penguin abundance with trends in krill biomass can explain why these penguin populations increased after fur seals and baleen whales were nearly extirpated and are currently decreasing in response to climate change." (V1-17 presentation)

Aileen Miller and Jarrod Santora (SWFSC, contractor); Anthony Cossio (SWFSC); Christian Reiss (SWFSC); Wayne Trivelpiece (SWFSC); Joe Warren
Penguin foraging behavior and diet in relation to krill distribution from spatially and temporally synchronous studies, Livingston Island, Antarctica
"Seabirds can be effective indicators in the marine environment if the relationships with their prey are closely understood. To understand this relationship, studies of predator and prey need to be conducted at concurrent spatial and temporal scales. In this study we tracked penguin foraging locations, diving behavior and diet while conducting simultaneous krill acoustic and net surveys within the penguins' foraging range over 3 years. Krill abundance varied by several orders of magnitude during the study, yet there was little evidence of changes in penguin foraging locations or diet. Diet samples of both species contained almost exclusively krill. The lengths of krill were similar to those caught in nets, though both penguin species exhibited a bias towards female krill. There was little spatial variability in either krill or penguin distributions, indicating that this location is predictable in terms of profitable foraging locations. Furthermore, chinstrap and gentoo penguins exhibited greater differences in foraging areas between the species than among years. This finding suggests that species specific foraging strategies and/or competition between the species play more important roles than krill biomass in determining behavior during the chick-rearing period. Surprisingly, there was little evidence of improvement in penguin chick-rearing success with increased krill availability." (P2-118 poster)

Ana Paula Carneiro and Michael Polito; Martin Sander; Wayne Trivelpiece (SWFSC)
Abundance and spatial distribution of sympatrically breeding Catharacta spp. (skuas) in Admiralty Bay, King George Island, Antarctica
"We examined the abundance and spatial distribution of sympatrically breeding skuas (*Catharact*a spp.) within Admiralty Bay, King George Island, Antarctica during the austral summer of 2004/2005 in relation to spatial variables, which correspond to access to resources and nesting site safety and quality. We also compared the distribution and abundance of skua pairs observed in 2004/2005 to published skua census data from 1978/1979. Similar to previous studies, we found that brown skua (*C. Antarctica lonnbergi*) pairs often nested in close proximity to penguin colonies and actively excluded other pair types from having direct access to penguin resources. In areas directly around penguin colonies, brown skua displace south polar skua (*C. maccormicki*) and other pair types, indirectly forcing them to nest in possibly lower quality territories, which are farther away from the coastline and in areas with lower incident solar radiation. When examining skua population trends, we discovered that the total number of breeding skuas in Admiralty Bay had increased by 293%, from 128 to 468 pairs, since 1978/1979. This dramatic increase was driven primarily by a tenfold increase in south polar skua pairs, as well as smaller increases in mixed and hybrid pairs. In contrast, there has been an overall decline (by 40%) in brown skua pairs during this same time, driven primarily by a large decrease in the breeding density of brown skua pairs in areas without penguin colonies." (P1-114 poster)

P2-147 Pablo Garcia-Borboroglu and P. Dee Boersma; Phil Trathan; Klemens Putz; Barbara Wienecke; Yvon Le Maho, Gerald Kooyman; Thomas Mattern; Robert Crawford; Underhill Les; Jessica Kemper; Peter Dann; Ursula Ellenberg; Phil Seddon; Yolanda Van Heezik; Antje Steinfurth; F. Hernan Vargas; G. Jimenez-Uzcategui; S. Naranjo; Charles Bost; Karine Delord; Heather Lynch; Lloyd Davis; M. Cerdena; Patricia Majluf; Richard Cuthbert; Wayne Trivelpiece (SWFSC); Mark Hindel
Penguin status in troubled oceans
"Marine and coastal ecosystems are undergoing unprecedented alterations in their processes and structure. Penguins are sensitive species impacted by these phenomena. As top predators, they are key constituents of marine ecosystems, and are indicators of the oceanic and coastal ecosystem health. We integrated the most updated information on distribution, abundance and trends for all penguin species. IUCN listed

60% of the 18 penguin species as vulnerable or endangered. Some threatened species are at their lowest recorded populations: Galapagos, Yellow-eyed and Fiordland, with their restricted ranges, have less than 3,000 pairs; Humboldt, Snares and African, have less than 30,000 pairs. Even abundant species like the Macaroni, and Rockhopper penguins are in steep decline. Around 80% of the threatened species occur on islands, increasing their vulnerability to threats such as introduced predators. Threatened penguins are mainly concentrated in New Zealand, East-Pacific Coast (Galapagos and Peru-Chile), and South-Africa. The status of penguin species is not improving. Anthropogenic sources of mortality are likely to increase and are drivers of the decline of penguins. Oceanic threats include climate change, marine pollution, and fisheries mismanagement. Prey availability potentially linked to climate variation is one of the most commonly suggested causes of population decline. Human activities, including irresponsible tourism, coastal development, and introduced predators, can have a major impact on penguin populations. As ocean samplers, penguins provide insight into the magnitude and location of marine conservation problems. Larger scale ecosystem-based conservation planning and more focused local efforts are needed for the successful conservation of many penguin species." (P2-147 poster)

Lewis Van Fossen (PIRO)
Seabird mitigation measures in Hawaiian longline fisheries
"The U.S. National Marine Fisheries Service's Pacific Islands Regional Office (PIRO) annually issues reports detailing seabird interactions for its pelagic longline fisheries. These reports can be accessed on the PIRO web site at: http://www.fpir.noaa.gov. Seabirds, mostly albatrosses (*Phoebastria* spp.), are captured incidentally to fishing operations in both the deep-set and the shallow-set pelagic Hawaii longline fisheries. The deep-set fishery targets tunas (*Thunnus* spp.), while the shallow-set fishery targets swordfish (Xiphias gladius). Seabird mitigation measures (50 CFR 665.815) were originally implemented due to the possibility of interactions with the ESA-listed short-tailed albatross (Phoebastria albatrus). With the mitigation measures in place, overall seabird interactions were reduced by over 90% even after the re-opening of the shallow-set fishery in 2004. Gilman et al. (2008) demonstrated that albatross capture rates were reduced by 67% in the deep-set fishery. Seabird mitigation measures developed in Hawaii were used to help develop conservation management measures (CMMs) adopted internationally by the Western and Central Pacific Fisheries Commission (WCPFC) in 2007. However, the WCPFC CMMs contain additional measures, such as tori lines, that are not required in Hawaii longline fisheries." (P2-7 poster)

Stephani Zador (AFSC) and Ed Melvin
Fast-tracking seabird data into Alaskan fisheries management decisions
"Seabirds are numerically-abundant top predators in Alaskan marine ecosystems. They interact with fisheries through competition for prey, foraging on fisheries discards, and physical interaction with fishing gear. Because both direct (e.g., bycatch mortality) and indirect (e.g., demographic responses to fishery-based ecosystem impacts) effects occur, seabirds are a concern for fisheries managers and ecosystem scientists alike. By mandate, commercial fisheries in the United States must be managed using ecosystem-based fishery practices. However, methods to accomplish ecosystem-based fishery management are still in development. In Alaska, ecosystem data are currently integrated into decisions made by the North Pacific Fishery Management Council, the body responsible for setting annual fisheries quotas. In this talk I will review how seabirds have been incorporated into fishery management decisions through the required protection of endangered species, through bycatch mitigation, and through research on the distribution, abundance and demography of seabirds with respect to fisheries activities. Mechanisms for further inclusion of seabird data in management decisions will be discussed, as will the mechanisms that currently exist but are not fully utilized for effecting management changes by incorporating seabird data directly into the management process." (C6-4 presentation)

George Hunt and Stephani Zador (AFSC); Alexander Kitaysky; G. Vernon Byrd
Climate variability and the responses of kittiwakes and murres breeding at the Pribilof Islands: what have we learned over 30 years?

"Climate-related impacts on seabirds occur over a wide range of temporal scales, from that of individual storm events, to the timing of seasonal transitions, to large-scale impacts on marine ecosystems and their ability to support prey resources in the vicinity of a colony. It this paper, we present examples of climate-related phenomena that have affected seabirds breeding at the Pribilof Islands. There, the timing of chick loss in black-legged kittiwake (*Rissa tridactyla*) nests with two chicks is related to the occurrence of storms, while the timing of nesting is related to winter conditions (ice cover, sea-surface temperature) and delayed transitions to summer conditions (late-melting snow banks affect the availability of cliff-face nesting sites). Climate variability can influence prey availability through changes in prey recruitment, distribution, or interactions with competitors for shared resources. Decadal-scale changes in the composition and or abundance of prey species affects the ability of parents to complete egglaying, successfully incubate eggs to hatching, and to fledge young, once hatched. Additionally, variations in the work required to raise young may affect the stress levels of adults and their ability to survive the post-breeding period and to return to breed in subsequent years. Thus, not only may direct climate impacts affect seabirds, but also indirect impacts on food supplies may affect not only breeding success, but also adult survival that, in turn, strongly impacts demography." (V1-12 presentation)