



JANUARY 20-24, 2014

# Alaska Marine Science Symposium

HOTEL CAPTAIN COOK & EGAN CENTER • ANCHORAGE, ALASKA



Henry Huntington



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SHOWCASING OCEAN RESEARCH IN THE  
ARCTIC OCEAN, BERING SEA, AND GULF OF ALASKA

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<b>7:15</b> <b>8:30</b>	Bering Sea/Aleutian Islands And Gulf Of Alaska	Second Wave	

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## **Keynote and Plenary Abstracts**

## **Looking Back 25 Years: EVOS In The Rear View Mirror**

**Dr. Robert Spies**, [spies.b@gmail.com](mailto:spies.b@gmail.com)

Nearly 25 years ago the *Exxon Valdez* ran up on Bligh Reef, Prince William Sound and spilled almost 12 million gallons of oil, the largest natural disaster in Alaska since the 1964 earthquake. This talk summarizes spill effects and the human reaction, emphasizing events before 2002. The timing of the spill in March 1989 could not have been worse for marine wildlife as it was the start of the productive season. The EVOS toll was unlike anything seen in past spills and recovery was uneven; with decreases in the salmon and herring fisheries, the outlook in 1994 was grim. That same year several large ecosystem-based studies were initiated to find out why recovery was not proceeding as expected. The study results added immensely to current knowledge of the ecosystem and in many ways laid the foundations for subsequent studies by the Trustee Council, NSF and the North Pacific Research Board, as well as the Alaska Marine Science Symposium. The scientific knowledge and environmental protection gained during the restoration program is a lasting legacy for Alaska marine conservation and science.

Dr. Robert Spies has a Ph.D. in marine biology from the University of Southern California. He has more than 40 years of experience and 50 publications in marine ecology and aquatic toxicology, characterizing marine pollution and its effects in a variety of coastal environments in North America, Australia and Micronesia. Dr. Spies was Chief Scientist for the federal-state *Exxon Valdez* Oil Spill Trustee Council following the *Exxon Valdez* Oil Spill in Alaska.

**The 1964 Great Alaska Earthquake: Lessons Learned In The 50 Years Since The Dawn Of Plate Tectonics**

**Dr. Peter Haeussler**, pheuslr@usgs.gov

This presentation provides a geologic overview of what happened during the 1964 earthquake. It begins with the large-scale tectonic processes operating over hundreds to millions of years that caused this massive earthquake to happen in southcentral Alaska. The 1964 earthquake affected the landscape through uplift and subsidence over large areas, with submarine landslides resurfacing the bottom of many fjords in southcentral Alaska. Studies of coastal marshes reveal the prehistoric record of these earthquakes. Glacial expansion during the Little Ice Age put more sediment at fjord margins, which resulted in particularly large and numerous tsunamis in the 1964 earthquake. The 1964 earthquake strongly influenced our understanding of these giant subduction zone earthquakes and their role at producing transoceanic tsunamis (such as Tohoku, Great Chile, Indonesia, etc).

Dr. Haeussler received his Ph.D. in Geology from U.C. Santa Cruz in 1991. He has worked at the USGS in Anchorage for 23 years, now as chief of the USGS' Alaska Earthquake Hazards Project and the coordinator for USGS earthquake hazards work in Alaska. He is an author (first author or co-author) on more than 90 publications and more than 125 abstracts. He has broad expertise in earthquake hazards, tectonics, and landscape evolution of Alaska.



**When The Goal Is To Get The Fishing Industry NOT To Catch Fish: Industry And Government Working Together To Reduce Salmon Bycatch In The Bering Sea Pollock Fishery**

**John Gauvin**, [gauvin@seanet.com](mailto:gauvin@seanet.com)

The incidental catch of Chinook salmon in Alaska trawl fisheries caught the attention of industry and government scientists in 2007, with approximately 120,000 Chinooks taken in the Bering Sea pollock fishery. Multiple solutions were needed, including the possibility of modifying pollock nets to allow salmon escapement. NOAA's Alaska Fisheries Science Center scientists, pollock fishermen and gear manufacturers have collaborated to develop devices to "exclude" salmon from trawl nets without injury while maintaining Pollock catches. While salmon "excluders" are just one tool in fishermen's toolbox for controlling bycatch, the vast majority of Bering Sea pollock fishermen use them today. Mr. Gauvin's talk will highlight the research and performance results of this innovative partnership. Video clips and sonar images from critical stages in the research will be shown with commentary.

John Gauvin has a Masters of Science degree in Resource Economics from the University of Rhode Island and is currently the Fisheries Science Director for the Alaska Seafood Cooperative. Over the last 25 years Mr. Gauvin has worked in fisheries management as a fishery economist as well as completing various consulting contracts with NOAA Fisheries, regional fishery management councils, FAO, and the OECD. Mr. Gauvin also serves on the North Pacific Research Board and is president of the Marine Conservation Alliance.

## **Alaska's Shelf Seas: Oceanographic Habitats And Linkages**

**Dr. Thomas Weingartner**, TWeingartner@alaska.edu

Alaska's shelf seas share an inherent commonality insofar as they are aligned along a series of advective pathways that transport water from the Pacific to the Arctic Ocean. That transport is a consequence of global-scale processes, in which Alaska's shelves play an important role. Despite this commonality, they are remarkably diverse in both their physical and biological characteristics. These differences arise largely as a consequence of how their geomorphology affects the response of oceanic responses to regional atmospheric and astronomical forcing. In aggregate these processes establish a myriad of marine habitats each having different degrees of connectivity to one another. This talk will focus on the unique role that freshwater forcing, primarily that associated with coastal discharge, has in shaping Alaska's marine ecosystems.

Dr. Weingartner earned his Ph.D. in Physical Oceanography from North Carolina State University. He came to the University of Alaska Fairbanks, first as a postdoctoral fellow in 1968, then as research associate in 1991, and has been a member of the UAF faculty since 1993. During this time he has become one of the preeminent physical oceanographers in Alaska and the United States. He is frequently tapped to participate in integrated research programs and serve on research organization advisory committees. He is the winner of the 2014 Ocean Leadership Award for Alaska Marine Research.

*Arctic - Climate and Oceanography*

**High-Resolution Hydrography Of The Northeastern Chukchi Sea From AUV Gliders And Towed CTD Surveys – A New Look At The Alaska Coastal Current, Upwelling And Fronts**

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Cayman Irvine  
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We use high-resolution (150-400 m horizontal spacing) hydrographic sections collected from AUV gliders and towed CTD transects over the July-October time period from 2010 to 2013 to describe water properties and circulation in the northeastern Chukchi Sea. These uniquely detailed observations reveal a complex and dynamic ocean structure, including 1-2 day shifts from a strong coastal jet directed towards Barrow Canyon to coastal upwelling and reserved flow. These rapidly modified circulation regimes are mainly driven by shifts in the wind forcing over the relatively shallow (40-m mean depth) shelf with a response time that is in concert with the spinup/down time scale for the shelf. Frontal structures at many scales are found across the study area. Nearshore (<15 m water depth) fronts separate local freshwater from offshore waters. Large-scale fronts divide the warmer Alaska Coastal Current from the colder offshore waters that are dominated by sea ice melt at the surface and winter waters deeper in the water column. Early September conditions were drastically different between 2012 and 2013, in part explained by persistent northeasterly wind forcing. Combined with two-dimensional surface current maps from high-frequency radar, satellite-tracked surface drifters, and time series of currents from sub-surface moorings, we develop a detailed description of the circulation and hydrography of this dynamic Arctic shelf sea.

*Arctic - Climate and Oceanography*

**A Revised View Of The Magnitude And Drivers Of Sea-Air CO<sub>2</sub> Fluxes In The Chukchi Sea**

**Claudine Hauri**, [chauri@alaska.edu](mailto:chauri@alaska.edu)  
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Dynamic and complex physical and biological processes drive sea-air CO<sub>2</sub> fluxes in the Chukchi Sea. Low surface pCO<sub>2</sub> due to high summertime primary production and subsequent shelf-to-basin transport of subsurface waters enriched with remineralized carbon into the Arctic Ocean are thought to support a globally important sink for atmospheric CO<sub>2</sub>. Here, we document a new mechanism of carbon cycling in the Chukchi Sea that substantially reduces the net strength of this globally significant carbon sink. Surface pCO<sub>2</sub> measurements and wind analysis show that annually occurring storm-induced mixing events during autumn months disrupt water column stratification and mix remineralized carbon from subsurface waters to the surface, leading to outgassing of CO<sub>2</sub> to the atmosphere. Our analysis provides a new understanding of the dynamics of carbon cycling in the region and suggests that late season wind events are strong and frequent enough to significantly decrease the carbon sink strength of the Chukchi Sea on a scale of relevance to the global carbon cycle. These results highlight the importance of obtaining data with high spatial and temporal resolution in order to accurately constrain regional to basin-scale carbon flux budgets. An accurate assessment of the present-day magnitude and drivers of regional sea-air CO<sub>2</sub> fluxes is crucial for future projections of atmospheric CO<sub>2</sub> concentrations.

*Arctic - Climate and Oceanography*

**Influence Of A High Spatial Resolution Arctic/Sub-Arctic River Discharge And Temperature Forcing On Modelled Nearshore Hydrography And Sea Ice Conditions**

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Compared to the rest of the world's oceans, the Arctic basin receives a large amount of fresh water. Relatively low salinity seawater enters the Arctic through the Bering Strait, but perhaps the most influential source of fresh water is the Arctic rivers; around 10% of the world's river discharge empties in to the Arctic Ocean, an ocean which represents only ~1% of the total world ocean by volume. Year round sampling in the Arctic is difficult and costly, and increasingly model results are used to understand Arctic processes. The Massachusetts Institute of Technology's general circulation model (MITgcm) is a high-resolution (~1/6°) coupled ocean-ice global model that has been used for many Arctic climate related studies, yet the current river discharge forcing has a resolution of 1° that is interpolated to the model grid. Consequently, input from many of the Arctic rivers is mis-located due to model land mask constraints, and spatial aliasing of river deltas occurs. In addition, fresh water is added at ambient ocean temperature, despite many of the Arctic rivers reaching temperatures of >10 °C during peak discharge between late May and mid-June. Using observations from the Arctic Regional Integrated Monitoring System (ArcticRIMS), the Arctic Great Rivers Observatory (ArcticGRO), and other gauged rivers, we present an improved river discharge forcing field at the same resolution as the model (~18 km), incorporates climatological monthly mean river temperatures and discharge, and is applied directly to the model grid without interpolation. We show results from a model run incorporating this new high-resolution discharge forcing and discuss the effects of increasing regional river runoff and temperature on freshwater and heat content budgets, and sea ice concentrations.



*Arctic - Climate and Oceanography*

**Downscaled Climate Model Information For Alaskan Coastal And Offshore Regions**

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Output from several global climate models, selected on the basis of their ability to simulate the recent climate of Alaska, has been downscaled for locations along and onshore of the Alaskan coasts. The variables include surface air temperature, wind and sea ice. Model output at daily resolution forms the basis of the downscaling, enabling a focus on extreme events in the historical (1970-present) and future (through 2100) time periods. The statistical methodology employed in the downscaling is quantile mapping, which captures the full distribution, including its extremes, of the downscaled variables. The results of the downscaling show that high-temperatures rarely reached in recent decades will be exceeded with increasing frequency over the 21st century at all locations, especially under a higher-range scenario of greenhouse gas emissions. Similarly, the extreme low temperatures become increasingly rare over the future decades. While high-wind events show little trend in frequency of occurrence in the downscaled output, the percentage of high-wind events occurring with open water along the western and northern coasts increases substantially as sea ice retreats. The ability of users to interface with the downscaled products via “shiny apps” will be highlighted in the presentation.

*Arctic - Lower Trophic Levels***The Importance Of Arctic Meiofauna And The Effects Of Environmental And Biological Variables On Their Distribution And Density In The Northeastern Chukchi Sea**

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Interactions between environmental and biological characteristics with meiofaunal communities on the Alaskan arctic shelf may contribute to the regional variations of the carbon pool and meiofaunal consumer distributions. Meiofauna (organisms 44 to 1000  $\mu\text{m}$  long) fill roles in carbon cycling, nutrient regeneration, and trophic interactions, although they have not been well-studied in the Chukchi Sea, a region where anthropogenic and natural environmental changes are occurring. Understanding how these communities of smaller organisms interact with environmental characteristics is important in predicting potential changes in trophic interactions for macrofauna feeding on these organisms. Meiofauna samples were collected in the northeastern Chukchi Sea at 31 stations. Samples were taken from van Veen grabs using a small core with a 7cm diameter to collect surface sediments to 1cm depth, and a 1.5cm diameter core to collect sediments to 5cm depth. Density values were obtained after following a compilation of silica solution separation techniques and using stacked sieves (500  $\mu\text{m}$  and 64  $\mu\text{m}$ ) to remove meiofauna from the surface sediment cores. Organisms were counted and identified to order or lower. The deep cores were sorted for major permanent meiofauna (i.e. nematodes, copepods, and foraminifera) and fauna analyzed for carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) tissue isotopes and carbon content. A total of 44 meiofaunal taxonomic categories were identified. The permanent faunal group Nematoda contributed most to meiofaunal density (7-11 ind.  $\text{cm}^{-2}$ ), followed by groups Copepoda (0.4-0.8 ind.  $\text{cm}^{-2}$ ), and Foraminifera (0.0-.03 ind.  $\text{cm}^{-2}$ ). Temporary groups with highest contribution to density were Polychaeta (0.2-0.48 ind.  $\text{cm}^{-2}$ ) and Bivalvia (0.1-0.3 ind.  $\text{cm}^{-2}$ ). Nematodes had the highest biomass, with average of 20 mg C  $\text{m}^{-2}$  ( $\pm 1.2$  SE), as compared to  $\sim 1.2 \times 10^4$  mg C  $\text{m}^{-2}$  ( $\pm 0.5 \times 10^3$  SE) for macrofauna. Longitude and bottom-water temperature were significant predictors of total meiofaunal density, overlapping with patterns observed for the macrofauna. Given the short generation times of meiofauna ( $\sim$ days to several months), carbon biomass estimates suggest they are significant sources of organic carbon in the meiofauna communities of the Chukchi Sea, and appear to covary with trends for macrobenthic communities.

*Arctic - Lower Trophic Levels***An Alternate Mechanism For Macrobenthic Distributions In The Chukchi Sea****Arny Blanchard**, [alblanchard@alaska.edu](mailto:alblanchard@alaska.edu)

Pelagic-benthic coupling is a major determinant of macrobenthic communities in the shallow waters of the Chukchi Sea. There are, however, significant deviations in macrobenthic characteristics driven by other mechanisms, including topographic control over water circulation. Water circulating around the north edge of Hanna Shoal converges with water moving to the east across the shoal's southern flank resulting in stagnant flow to the southeast of the shoal. The stagnant circulation is associated with delayed flushing of winter-water in summer, a cold-water pool, increased stratification, habitat variations, high macrobenthic biomass, and high marine mammal feeding activity; the increased benthic production cannot be explained by pelagic-benthic coupling alone. Macrobenthic communities were sampled with a 0.1 m<sup>2</sup> van Veen grab in the northeastern Chukchi Sea in 2011 and 2012 to understand broad-scale mechanisms controlling the ecology of the region. Sediments were washed over a 1.0-mm mesh sieve and the sediment-dwelling fauna (macrobenthos) were preserved, and were identified, counted, and weighed in the laboratory. Environmental parameters, sediment grain-size, sediment organic carbon content, water depth, and bottom-water salinity and temperature, were also determined. Spatial structuring of the macrobenthos is strong and environmental measures reflecting normal benthic processes and pelagic-benthic coupling (e.g., water depth, percent mud, and sediment organic carbon content (OC)) are weak predictors of macrobenthic characteristics which show strong spatial interactions. Additional physical processes proxied by latitude and longitude (circulation patterns, carbon advection, etc.) are important in defining faunal distributions; latitude, longitude, and OC are significant predictors of density for the polychaete *Maldane sarsi* and latitude, longitude, and water depth for the bivalve *Ennucula tenuis*. Biodiversity also demonstrated spatial patterns as latitude, longitude, percent mud, and bottom-water temperature were predictors of the total number of taxa per station. Amphipod and polychaete diversity demonstrated the greatest spatial change decreasing by 21 (40%) and 39 (33%) taxon groups south to north, respectively. Overall, the complex distributions of the biotic variables indicate that the indirect effect of topography on macrobenthic assemblages appears to be a strong driver for community characteristics and provides an alternate mechanism for areas of increased benthic production in some areas of the Chukchi Sea.

*Arctic - Lower Trophic Levels***Toward A Contemporary Baseline For Zooplankton Communities In The American Beaufort Sea**

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Zooplankton are important conduits from primary production to higher trophic levels, yet they have been poorly assessed throughout much of the Beaufort Sea. Zooplankton assemblages are being characterized for the US Beaufort Shelf as part of a multiyear, multidisciplinary effort from 2011-2014. In 2011 a total of 79 taxonomic categories were observed, including 68 holoplanktonic categories and 11 meroplanktonic categories. The community in the study area was dominated by copepods, larvaceans, and cnidarians, although relative importance varied between inshore-offshore and along east-west gradients. Using a 150  $\mu\text{m}$  net, the average abundance and biomass was  $\sim 1800$  individuals  $\text{m}^{-3}$  and 20 mg dry-weight  $\text{m}^{-3}$ , respectively. The average abundance using a 505  $\mu\text{m}$  net was 16% of that captured by the 150  $\mu\text{m}$  net; however, the average biomass captured by the 505  $\mu\text{m}$  net was nearly 90% of that observed in the 150  $\mu\text{m}$  net. Generally, species were characteristic of the Arctic domain, with a mixture of neritic species, such as *Pseudocalanus* spp. and oceanic species, such as *Calanus hyperboreus*. These results will be compared with data from the 2012 field season. An improved understanding of the composition, spatial distribution, and seasonal and inter-annual variability of the zooplankton community of the Beaufort Sea is needed to understand trophic linkages and establish a modern reference point from which to compare datasets spanning over 60 years for signals of long term change.

*Arctic - Fish and Fish Habitat***Arctic SHELFZ (Shelf Habitat and EcoLogY of Fish and Zooplankton)**

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The Arctic nearshore habitat is an important region used by native communities to harvest marine mammals and fish. As many of these areas are inaccessible to most research vessels, there is a limited understanding of fish and zooplankton ecology in the transition area between nearshore and offshore habitats. This is the first survey in which nearshore (< 20 m isobath) and offshore data (> 20 m isobath) have been concurrently collected for fish, zooplankton, fisheries acoustics, and water mass properties along Alaska's Chukchi Sea coast. Surveys were conducted between the communities of Barrow and Wainwright in August-September 2013. Transects extended from the beach to 75 km offshore, covering an area of 8,580 km<sup>2</sup>. Beach seines, bottom and midwater trawls, fisheries acoustics (38kHz, 120 kHz), zooplankton tows, and CTD casts were conducted nearshore aboard the R/V Ukpik and offshore aboard the F/V Alaska Knight. The overall goal of this project is to identify the characteristics of the transition zone between the nearshore and offshore habitats and the diet, body condition, age structure, abundance and distribution of fish. We present the abundance and distribution of selected fish and invertebrate species. Benthic invertebrates dominated the catches in the nearshore and offshore bottom trawls. The most abundant fish and invertebrate species in the bottom trawls were Arctic cod, kelp snailfish and warty sculpin, sea cucumbers and sea stars in the offshore and Arctic staghorn sculpin, snailfish, slender eelblenny, shrimp and mysids in the nearshore. The most abundant fish and invertebrate species in the midwater trawls were Arctic cod, Arctic staghorn sculpin, capelin and jellyfish in the offshore and Arctic cod, Arctic staghorn sculpin, Arctic sculpin and jellyfish in the nearshore. In the beach seines the most abundant fish and invertebrates were Arctic staghorn sculpin, sand lance fourhorn sculpin and mysids. This study contributes new baseline information to our understanding of the ecology of nearshore and offshore habitats.



*Arctic - Fish and Fish Habitat***Fish Diets Across The Chukchi And Beaufort Seas****Benjamin Gray**, bpgray@alaska.edu

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Diet information for Arctic Cod (*Boreogadus saida*), Arctic Staghorn Sculpin (*Gymnocanthus tricuspidis*), and Shorthorn Sculpin (*Myoxocephalus scorpius*) is limited, outdated, from distant regions, or nonexistent. We collected these species during ice-free months over three years in the Chukchi Sea (2010–2012) and one year in the Beaufort Sea (2011). Diets were compared by four factors: seas, regions, depths, and size classes. Diets of each of the three fish species differed between the Chukchi and Beaufort seas and small and large fish fed differently. In general, Arctic Cod and Shorthorn Sculpin fed more pelagically in the Beaufort Sea and more benthically in the Chukchi Sea. Arctic Staghorn Sculpin fed benthically in both seas. Smaller Arctic Cod consumed more calanoid copepods in both seas while larger fish ate a more varied diet. All sizes of both sculpin species ate more benthic amphipods in the Chukchi Sea. Smaller and larger Arctic Staghorn Sculpin in the Beaufort Sea ate other types of prey and polychaetes respectively. Smaller Shorthorn Sculpin in both seas ate hyperiid amphipods whereas larger Chukchi Sea fish ate fish prey and shrimps. Additional diet differences were indicated by regional analysis; however, the effect of depth appeared to be confounded by fish size. This is the first account of factors contributing to variability in diets of fishes across the Chukchi and Beaufort seas and of Shorthorn Sculpin diet across the Chukchi and Beaufort seas. As arctic conditions change, analyzing fish diets may help indicate shifts in arctic food web structure.

*Arctic - Fish and Fish Habitat***Growth Rates Of Juvenile Arctic Cod (*Boreogadus Saida*) And Saffron Cod (*Eleginus Gracilis*) In A Warming Ocean**

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Both Arctic cod (*Boreogadus saida*) and saffron cod (*Eleginus gracilis*) co-occur in the Arctic, but growth data are too few to model how they will respond to changing climate scenarios in the region. In this study, we experimentally measured the temperature-dependent growth, condition and activity levels of each species across 4 temperatures (0, 5, 9 and 16°C) at the Alaska Fisheries Science Center's cold-water laboratory at the Hatfield Marine Science Center in Newport, OR. Age-0 juveniles of both species were collected and live-shipped from the Beaufort Sea in August 2013 to initiate experiments. Results indicated clear physiological and behavioral difference between the two species. Arctic cod demonstrated a cold-water, stenothermic response in that there was limited growth potential beyond 5°C, and there was a sharp decrease in condition, activity, growth and survival at 16°C. In contrast, saffron cod demonstrated a warmer-water, eurythermic response in that growth rates and activity increased linearly up to 16°C, with some indication that condition was negatively impacted at the lowest temperature (0°C). Together, these data indicate saffron cod will be able to better exploit warming conditions than Arctic cod, especially in coastal areas where temperatures already exceed 14°C in the summer and nutrient input is high due to river runoff. These results, coupled with a possible northward shift of other gadid species (i.e., walleye pollock *Gadus chalcogrammus*), suggest Arctic cod are highly vulnerable to continued climate change in the Arctic.

*Arctic - Fish and Fish Habitat*

**Dispersal Patterns And Summer Oceanic Distribution Of Adult Dolly Varden From The Wulik River, Alaska, Evaluated Using Satellite Telemetry**

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Dolly Varden make up an important component of subsistence fisheries in northern Alaskan communities. While it is known that Dolly Varden may be broadly distributed throughout a wide range in the Pacific Ocean during the summer, their distribution in the Chukchi Sea is unknown. Therefore, in June of 2012 and 2013, we attached 52 Pop-up Satellite Archival Transmitting (PSAT) tags to Dolly Varden in the Wulik River, which flows into the Chukchi Sea, to examine their dispersal and behavior. PSAT tags measured and recorded temperature, depth and ambient light data at 2 minute intervals while externally attached to the fish. From 1 July– 1 October, in two week intervals, these tags released from the fish, floated to the surface of the sea and transmitted, via satellite, the pop-up position and archived data. To date, nine of the fish provided the first documented northwesterly offshore dispersal to the Russian Chukchi Sea. While at sea, they dispersed up to 60 km/day and frequently occupied (>90%) relatively shallow water (<15 m). Other dispersal types were demonstrated, including Wulik River residency, southerly alongshore dispersal, and movement to rivers in Russia and Western Alaska. Because many of the tagged fish appeared to occupy the outer continental shelf of the Chukchi Sea, this region may be an important summer feeding area for northwestern Dolly Varden. Furthermore, because of its ability rapidly transit broad areas of the Chukchi Sea and frequently occupy shallow water, this important subsistence species may be exposed to emerging human activities, such as hydrocarbon development and shipping.

*Arctic - Seabirds*

### **Broad Scale Climatic Influences Are Stronger Drivers Of Survival Than Local Impacts For An Arctic Seabird**

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While arctic breeding seabirds experience extreme weather and climatic conditions, those species that also winter in the arctic endure even more environmental extremes throughout their life cycle. Variation in environmental conditions is a function of both short-term weather events and longer-term climatic variation tied to atmospheric teleconnections, such as the Arctic Oscillation and Pacific Decadal Oscillation. We examine the relationship between the survival probability of 1,962 marked black guillemots (*Cephus grylle mandtii*) breeding at Cooper Island, Alaska, USA and climatic variables affecting both breeding and wintering areas over a 37-year period (>10,000 bird/year observations). Black Guillemots are year-round resident of the Arctic and monitoring their annual survival allows examination of annual variation in the marine ecosystems that support them. We applied Bayesian multi-state mark-recapture models to examine the effects of environmental covariates on survival probability of breeding adult guillemots. Recapture and resighting probability of breeding adults was very high in this study (~1.0) allowing for precise parameter estimates and separation of components of variation. Guillemot survival probability was negatively correlated with winter Arctic Oscillation, and weakly positively correlated with the Pacific Decadal Oscillation. Adult survival is highest when Arctic atmospheric temperatures are cold as is shown by a negative correlation with the winter AO. Survival probability was not correlated with distance to ice during the breeding or southern extent of winter ice cover. In addition, survival probability was not related to sea surface temperature around Cooper Island, an important correlate with forage availability. Our results suggest that broad-scale climatic effects have a stronger influence on breeding adult survival probability than local-scale effects influencing effort required for raising young. Understanding the patterns in variability of black guillemots allows us to better interpret unusual survival events given the anticipated changes in resource use and climatic conditions in the Arctic coastal region of Alaska.

*Arctic - Seabirds*

### **Shifts In The Seabird Community Of The Chukchi Sea Over Four Decades: A Sea Change In Structure?**

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Summer ice cover in the Arctic Ocean reached the lowest minimum extent on record in 2012. This decline is anticipated to have repercussions on the trophic structure in this environment, and there is evidence that the seabird community of the eastern Chukchi Sea shelf already has changed over the past four decades. We quantified sea-ice cover and compared ship-based survey data collected in the eastern Chukchi Sea during 1975–1981 (historical data) with surveys conducted during 2007–2012 (recent data) to explore how the seabird community may be responding to changes in the physical and biological oceanography of the region. Sea ice now forms later, melts earlier, and melts completely in all parts of the eastern Chukchi Sea than it did 30 years ago. The historical seabird community was composed predominantly of piscivorous Black-legged Kittiwakes (*Rissa tridactyla*) and murrelets (*Uria spp.*). In contrast, the seabird community today is composed predominantly of Crested Auklets (*Aethia cristatella*) and Short-tailed Shearwaters (*Puffinus tenuirostris*), both species that prey primarily on euphausiids and other large zooplankton when they are available. New seabird species also have been added to the Chukchi avifauna since 2006, and several of them are planktivorous as well. Earlier ice retreat appears to be creating an environment that is more amenable to the production of euphausiids and other large zooplankters. We propose that the changes in abundance and composition of the seabird community reflect an increase in the availability of large zooplankton prey in the region.



*Arctic - Seabirds*

**Forage Quality For Pre-Migratory Semipalmated Sandpipers Using Three River Deltas On The Beaufort Sea, Alaska**

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Many shorebird species nesting on the Arctic Coastal Plain, Alaska, assemble on river deltas on the Beaufort Sea coast to forage after the breeding season and before fall migration. We have documented availability and use of food resources at the Canning, Jago, and Okpilak/Hulahula river deltas on the Arctic National Wildlife Refuge since 2010. However, we do not know which specific invertebrate taxa shorebirds feed on, when foraging switches from terrestrial ponds to delta benthic invertebrates, or the fattening rates of birds. To determine shorebird diet, we used stable isotope values of carbon and nitrogen of red blood cells and plasma collected from foraging semipalmated sandpipers and from common invertebrates collected on the deltas and nearby terrestrial tundra ponds. We also used blood samples to analyze triglyceride levels of shorebirds; blood triglyceride levels can be indicative of fattening rates, which can be used to compare forage quality among deltas. Our preliminary analyses indicated a significant separation between carbon isotopes found in invertebrates from tundra ponds and delta benthic habitats, and that there was a switch from terrestrial to benthic invertebrates at the beginning of our sampling season. Future analyses will determine which specific taxa were ingested. We found no difference in blood triglyceride levels among the three deltas or among feeding areas within deltas, suggesting that forage used by semipalmated sandpipers was of similar quality at all of the deltas. In the future we will address the importance of these deltas to the annual life cycle of semipalmated sandpipers by combining information on the nutritional value of ingested benthic invertebrates with shorebird and invertebrate abundance data to estimate energetic costs and benefits of feeding at these river deltas.

*Arctic - Mammals*

**The Effect Of Variable Detectability On Density Assessments Of Bowhead Whales During Seismic Survey Operations In The Beaufort Sea, Alaska**

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Aerial surveys are a common means to assess the densities of wide ranging animals such as bowhead whales (*Balaena mysticetus*). In the Alaskan Arctic, aerial surveys are part of environmental monitoring programs for oil and gas exploration. Sighting data collected during such surveys are used to estimate bowhead density—particularly the number of whales exposed to different received levels of seismic sound, as required by regulators. However, estimates of abundance may be over- or under-estimated if seismic operations affect how visible a whale is to aerial observers. The objective of our study was to determine the extent to which density assessments of bowhead whales are affected by changes in availability caused by seismic operations. We used bowhead sighting data collected during industry monitoring surveys of seismic operations conducted in the Beaufort Sea from late August to early October 2008. We then fit density surface models to these sighting data and incorporated availability correction factors to determine the sensitivity of density estimates to variable availability of bowhead whales. Finally we conducted a series of realistic simulated scenarios to evaluate the influence of behavioral responses on density estimates of whales that are disturbed or undisturbed by seismic operations. Preliminary analyses suggest that the actual numbers of whales present in areas ensonified by seismic operations may be as much as 64% higher than estimates that only account for changes in availability of undisturbed whales. Our study highlights the influence of whale behavior on density assessments of bowhead whales in the vicinity of seismic operations.

*Arctic - Mammals***Real-Time Detection Of Arctic Marine Mammals From Ocean Gliders: A Pilot Study**

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Marine mammals are an integral part of the Arctic ecosystem, and there is an urgent need to monitor their distribution and occurrence as significant changes occur in that ecosystem. Arctic marine mammals are currently monitored with aerial surveys and passive acoustic recordings from moored instruments; however, aerial surveys are limited by weather conditions (e.g., low ceilings, fog) and long-term recordings are labor-intensive to process and provide occurrence information long after an animal is actually recorded on an instrument. We have integrated the digital acoustic monitoring (DMON) instrument in several autonomous platforms to detect and classify the calls of marine mammals and report those detections in near real time via Iridium satellite. The DMON is a programmable hardware device capable of both recording and processing audio from 1-3 hydrophones, and we have implemented the low-frequency detection and classification system (LFDCS) on the DMON to detect and classify calls via pitch tracking and discriminant function analysis. The system has been used successfully in the northwest Atlantic Ocean, and in 2013, we conducted a pilot study of the system in the Chukchi Sea. We first developed a DMON/LFDCS call library for Arctic and sub-Arctic marine mammal species with which detected sounds could be compared and identified. The call library consisted of 32 call types produced by bowhead, fin, humpback, right, beluga, and killer whales, and walrus and bearded seals. In September 2013, we deployed a single Slocum glider equipped with the DMON/LFDCS in the northeastern Chukchi Sea. The glider reported real-time detections of both bowhead whales and air guns used for geophysical exploration during its 7-day mission along the northwestern coast of Alaska between Wainwright and Barrow. The continuous audio recorded by the DMON/LFDCS during the pilot study was extremely valuable for identifying detection parameters and call types that can be tuned for better performance during future deployments. We envision that this mobile autonomous system will be a useful tool for both research and mitigation applications where access to real-time detection information can improve the efficiency of finding animals for study or reduce the impact of industrial activities on sensitive Arctic species.

*Arctic - Mammals*

**Diving Behavior And Habitat Use By Two Populations Of Beluga Whales  
(*Delphinapterus Leucas*) Across Variable Habitats Of The Pacific Arctic**

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Recent advances in satellite telemetry have revealed that some Arctic populations of beluga whales (*Delphinapterus leucas*) are highly migratory and extend their summer distributions to high latitudes covered with dense pack ice. Two beluga populations in the Pacific Arctic, the eastern Chukchi Sea and Beaufort Sea (ECS and BS, respectively), are known to migrate across hundreds of kilometers of Arctic habitat and range into >90% ice cover yet the drivers behind their spatial distribution are relatively unknown. Beluga whales are generalist foragers that have been documented to dive below 800 m in the eastern Arctic, yet there has not been a comprehensive analysis of their use of the water column throughout the range of diverse habitats in the Pacific Arctic. We used locations and dive characteristics of satellite-tracked whales to quantify spatial and temporal distribution patterns and time allocation within the water column as an indication of foraging behavior. Using satellite-linked time-depth recorders attached to whales from 1997-2007 (n=28), we quantified summer and autumn sex-specific beluga whale diving behavior and resource selection between ECS and BS belugas. Kernel density estimators were used to calculate spatial and temporal overlap in monthly core areas. Dives were summarized from binned dive data to analyze differences in the number of dives to specific depths, dive:depth ratio, dive durations, and occupancy time at depth between the two populations. Monthly core areas of the two populations were largely distinct until September when we documented an east-west shift in focal area use between populations that persisted into October. Our study also contrasts differences in diving behavior between populations using mixed effect models with repeated measures in their summer core areas as well as among several sub-regions such as the Chukchi Plateau, Barrow Canyon, Alaskan and Canadian Beaufort Sea slopes, eastern Canada Basin slope, and Canada Basin. Environmental features such as seafloor slope and depth, the Beaufort shelf-break jet, upwelling centers, and regional water masses differentially influence diving behavior and habitat use of Pacific Arctic belugas, which are factors that presumably enhance prey availability and motivate the distribution and diving patterns we observed.

*Arctic - Mammals***Recent Trends In Pacific Walrus Demographic Rates**

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Global climate change threatens to alter the population dynamics of many species for which baseline demographic rate and population size estimates are imprecise or lacking. The Pacific walrus (*Odobenus rosmarus divergens*) exemplifies this predicament. Harvest is thought to have been the primary mortality factor affecting Pacific walruses for at least the past two centuries, but reduced availability of sea ice due to global warming may change the limiting factors for this population. In particular, it is hypothesized that the loss of late summer sea ice, which walruses use as a resting platform between foraging bouts, may reduce access to food, and through nutritional stress, may lower reproduction, calf and juvenile survival, and possibly adult female survival. However, rigorous estimates of walrus survival rates do not exist, reproductive rate estimates are decades old, and estimates of population size have well documented bias and imprecision. The limited information available for the species requires combining disparate sources of data to provide useful estimates of population parameters and their associated uncertainties. To accomplish this, we developed a Bayesian, hidden process demographic model of walrus population dynamics from 1974 through 2006 that combined annual age-specific harvest estimates with five population size estimates, six population age structure estimates, and two reproductive rate estimates. The model suggests density independent survival (exclusive of harvest mortality) was relatively high for both adults (0.99) and juveniles (0.97) and that annual density dependent vital rates rose from 0.06 to 0.11 for reproduction, 0.31 to 0.59 for survival of neonatal calves and 0.39 to 0.85 for survival of older calves, concomitant with a population decline during the period. The current model provides a baseline and is designed to incorporate additional data as it becomes available for estimating changes in demographic rates and forecasting population consequences that may result from changes in harvest or diminishing sea ice.

*Arctic - Mammals***“It’s A Good Time To Be A Bowhead”: Body Condition And Links To Summer Sea Ice And Upwelling In The Beaufort Sea**

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We examined the effects of summer sea ice conditions and upwelling wind in the Beaufort Sea on the body condition of bowhead whales. We used a long-term dataset collected from whales harvested by Alaskan Eskimos to estimate two body condition indices (BCI) for each individual whale. A series of offshore regions frequented by bowhead whales in summer were designated and used to quantify year-to-year summertime environmental conditions including: a) mean open water fraction, b) total days with >75% open water, c) duration of melt season, d) date of continuous freeze-up, e) mean upwelling-favorable wind stress, and f) total days with upwelling-favorable winds. These metrics were analyzed relative to body condition for both the preceding feeding season and the previous three seasons combined. The strongest effects were found for a) the late summer open water fraction in the nearshore areas off the Mackenzie Delta and an offshore zone west of Banks Island, b) duration of melt season and date of freeze-up for the Beaufort Sea, and c) upwelling favorable wind stress for the Mackenzie shelf and west of Banks Island. Our analysis of the long-term BCI trend indicates a significant increase over the period study period (1989-2011). The long-term increase in BCI is likely associated with reduction of sea ice, duration of open water, upwelling potential (wind stress), and possibly higher production in the Western Arctic marine ecosystem favoring water-column invertebrates. Concurrent with study period the abundance of bowheads has increased markedly with a constant or accelerating annual rate of increase. We suspect that high body condition and the population increase are related. We also examined seasonal changes in BCI. A strong seasonal difference in BCI was noted particularly for sub-adult bowheads which is presumably associated with summer feeding; however, post-weaning yearlings drop in BCI over their first summer and possibly longer.

*Arctic - Humans*

**COMDA: Impact Monitoring For Offshore Subsistence Hunting**

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Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA): Impact Monitoring for Offshore Subsistence Hunting The purpose of this project is to initiate monitoring efforts of offshore subsistence hunting for key marine mammals among the two communities, Point Lay and Wainwright, that are most proximate to recent Outer Continental Shelf (OCS) oil and gas leases and to anticipated offshore exploration and development in the Chukchi Sea. The Bureau of Ocean Energy Management (BOEM) established an updated baseline in the area with three years of monitoring of offshore subsistence harvest activities. Stephen R. Braund & Associates (SRB&A) monitored offshore subsistence hunting in Point Lay and Wainwright beginning in March 2010 and continuing in 2011 and 2012. Collecting data on hunting and harvesting activities will allow for the assessment of potential effects related to development and the identification of mitigation strategies to help lessen those effects. This project involved working with local marine mammal hunters to document where offshore subsistence activities occurred with the use of Global Positioning System (GPS) units, followed by interviews with hunters to gather additional data about their offshore hunting trips. The study gathered data on the number and composition of hunting groups, duration of hunting activities, the locations of search areas and harvest strikes, number of prey harvested, hunting trip costs, and hunter observations regarding weather and ice conditions, access issues, increased hunting risks or costs, and resource changes.

*Arctic - Humans***Expanding the Toolbox: Integrating and Visualizing Arctic Data**

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Scientific data collection in the Arctic has grown exponentially in recent years through initiatives led by government, the oil and gas industry, and academic institutions. This includes real-time data, forecast models, time-series monitoring, and project level data. Continued effort is needed to maintain and expand these efforts. However, there is a simultaneous need to integrate existing information to better understand the environment, promote safe operations, and inform decisions regarding human activities. Integrating Arctic data is challenging. Many data sets are housed in isolated and physically dispersed agencies, sometimes across borders. Technical barriers such as complex data formats lack of standardization, and inadequate or nonexistent metadata have also made acquiring and using available scientific information a daunting task. As a result, existing data is often underused in current planning and decision-making processes. To help address these needs, the Alaska Ocean Observing System is developing interactive web-based tools to assist scientists, regulators, coastal managers, spill responders and citizens. This presentation will highlight the AOOS Arctic Portal — an online interactive mapping application that visualizes model output, real-time sensor measurements, satellite imagery, and GIS layers in a seamless interface. Users are able to choose from several hundred layer options including satellite imagery, ocean circulation and temperature models, habitat maps, environmental sensitivity indices, ice parameters, and other layers. The goal of this tool is to improve access to existing information that can benefit a wide spectrum of management efforts. Potential applications include marine shipping, off-shore development, conservation, climate change, and community planning.



*Arctic - Humans*

### **Gauging Perceptions of Ocean Acidification in Alaska**

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Ocean acidification (OA) has direct implications for the US fishing industry, but many individuals believe that more immediate threats to the ocean, such as pollution and offshore drilling, pose a greater risk. Evaluating how people view and value the implications of degrading ocean health, and how OA fits into this process can help determine where and how to focus OA outreach initiatives to maximize both understanding of OA and support for OA-related research and policy. This project will presents an interdisciplinary survey aimed to better understand the multitude of variables that influence the perceptions of the risk associated with OA, but also environmental literacy and support for mitigation efforts related to OA. Using these results, we were able to quantify the variables that influence individual willingness to support OA research and mitigation. Furthermore, information gained from the survey was used to better understand if and how individuals are reacting to the current variable degree of OA in different regions of Alaska. This has helped us identify where there are gaps in understanding of OA in Alaska, and how future OA initiatives can be implemented in order to prepare individuals, communities, and the fishing industry for future changes in ocean chemistry.

*Arctic - Ecosystem Perspectives***The Arctic Basins: An Integrated Physical And Biological Perspective****Bodil Bluhm**, babluhm@alaska.edu

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The Arctic Ocean (AO) is integral to the global ocean by exchange flows with the subarctic Atlantic and Pacific, with the Atlantic dominating by mass and heat fluxes, and the Pacific dominating in terms of impact on vertical stratification. Here, we summarize the status of knowledge on the Arctic Basins from a bio-physical perspective. Two basic water mass assemblies differ in the absence/presence of Pacific Water (PW) sandwiched between Arctic Surface Water above and Atlantic Water (AW) below, with characteristic expatriate planktonic biota in PW and AW, and strongly vertically structured zooplankton communities. The four basic large-scale circulation systems of the Arctic basins include (1) the northern thermohaline circulation that drives PW through Bering Strait into the Canada Basin (CB), and counter-flowing AW through Fram Strait (FS) across the Barents Sea into the Nansen Basin, (2) wind-driven circulation which forces the cyclonic Trans-Polar Drift from Siberia to FS and the anticyclonic Beaufort Gyre in the CB; (3) the topographically-trapped Circumpolar Boundary Current which carries AW cyclonically around the basin boundaries and PW along the southern boundary of the CB; and (4) slow exchanging Arctic Ocean Deep Waters which form in the Greenland Sea, enter through FS, and spread within the basin interior. Massive submarine ridges act as barriers to the free exchange of deep and bottom waters and constrain circulation, although they do not appear to fully prevent biotic dispersion. Owing to stratification-related nutrient limitation and light limitation mediated by snow, ice cover and sun angle, primary production is low, characterized by small phytoplankton and a sub-surface chlorophyll maximum in the Pacific Arctic. Advective inputs add food supplies to pelagic and benthic biota near the basin perimeter with decreasing pelagic and benthic biomass at increasing depths, and long food webs at great depths driven by refractory organic matter in a diverse, highly endemic benthos. The accelerating pace of change over the basins in the past decades is most obvious in the loss of ice volume and extent resulting in sea ice annually retreating past the shelf break, facilitating shelf-break upwelling of nutrients from subsurface basin-waters onto the shelves.

*Arctic - Ecosystem Perspectives***The Unique Physical Dynamics And Biological Seasonality Of Lagoon Ecosystems Along The Eastern Alaska Beaufort Sea Coast: Linkages To Food Webs And Carbon Resources****Kenneth Dunton**, ken.dunton@utexas.edu

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Coastal lagoons of the eastern Beaufort Sea are extraordinarily diverse with respect to their physical and biological characteristics and serve as critical habitat for an array of organisms of enormous ecological and subsistence value. Their unique physiography, a product of physical processes driven by ice, sediment transport, and freshwater inflows is linked to their importance as nurseries for an array of fauna and feeding grounds for over 150 species of migratory birds. Our work has revealed that these lagoons are subject to substantial seasonal variations in their hydrography, largely driven by the magnitude of water exchange processes with the Beaufort Sea, especially during the ice-covered period. Distinct vertical stratification in winter, likely a product of limited circulation and high water residence times, results in hypersaline (43) lagoon waters and net heterotrophic (values to 25% oxygen saturation) during winter, before rebounding during the period of ice break-up to net autotrophic (>100% saturation). In concert with these observed physical events, we find distinct seasonal patterns in microbial community structure, contributions of terrestrial and marine-sourced particulate organic matter (POM), and levels of inorganic-N. Our visits to study sites along the eastern Alaskan Beaufort Sea coast during both ice-covered and open-water periods reveal high concentrations of sediment chlorophyll in late winter and early spring, nearly twice that measured during the summer months. HPLC analyses revealed a high proportion of diatom pigments (*fucoxanthin*). Stable isotopic analyses of infauna and epifaunal species have confirmed the significant assimilation of marine carbon during the period of ice-cover, with increasing dependence on terrestrial organic matter through the summer, contrary to our original hypotheses on the seasonal importance of autochthonous vs. allochthonous carbon sources to lagoon food webs. Measurements of water and sediment chemistry, benthic and water column community characteristics, and natural abundance isotopic tracers promise to reveal the dynamic nature of these productive lagoon ecosystems under different hydrologic conditions. Our research has benefited from the special relationships we have developed with the community of Kaktovik through our field K-12 educational programs and partnerships with local citizens.

*Arctic - Ecosystem Perspectives***Seasonal And Spatial Patterns Of Marine-Bird And -Mammal Distributions In The Pacific Arctic: A Delineation Of Biologically Important Marine Areas**

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The Pacific Arctic is undergoing rapid climate change and increased human activity. Conservation efforts for apex predators such as marine birds and mammals will require information on species' distributions and identification of important marine areas. Our goal, as part of the multidisciplinary Synthesis of Arctic Research, was to describe broad-scale distributions of marine birds and mammals in the eastern Chukchi and western Beaufort seas. Bird and mammal distributions are influenced strongly by life history patterns and, in the Arctic, by the extent and timing of sea-ice coverage; therefore, we examined spatial patterns of relative abundance in summer (15 June–31 August) and fall (September–November). We integrated data from 2007–2012, including shipboard surveys for seabirds (~ 50,000 km surveyed) and aerial surveys for marine mammals (~139,000 km surveyed). We standardized survey data in 40-km grid cells and used Getis-Ord  $G_i^*$  hotspot analysis to test for cells with significantly higher densities. Analyses accounted for a strong “colony effect” for birds, extremely high densities of belugas over Barrow Canyon (BC), and anthropogenic attractants for polar bears. We identified density hotspots for selected species and areas that were hotspots for both birds and mammals. Among bird species, hotspots were often near underwater canyons or slope edges. The Bering Strait region was also a hotspot of bird density in both seasons, even after removing cells within 40 km of breeding colonies. Mammal species had hotspots near BC as well, and near a small canyon in Hope Basin. Gray whales also frequented the shelf off of Wainwright and walrus aggregated near Hanna Shoal. In fall, mammals showed a slight shift to the western Beaufort and farther offshore. The common hotspots for birds and mammals during summer were the mouth of BC, the head of BC off of Wainwright, and an area south of Hanna Shoal. In fall, only the mouth of BC was a significant hotspot for both groups. These static features are associated with strong fronts caused by upwelling and currents, and can have high densities of euphausiids in the summer and fall.

*Arctic - Ecosystem Perspectives*

**The Hanna Shoal Circulation Field In The Northeastern Chukchi Sea**

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Numerical ocean models have long-predicted a mean clockwise circulation around Hanna Shoal. The predicted flow field consists of waters flowing northward from the Bering Sea. Some of these flow through Herald Valley and then turn eastward where they merge and merge y with waters flowing northward from the Central Channel along the northwest side of Hanna Shoal. East of the Shoal, the modeled mean flow is southward along two branches: one path leads directly toward the head of Barrow Canyon, while the other flows to the south side of Hanna Shoal before turning eastward over the central shelf. Until recently there have been no systematic set of observations for the verification of these model predictions. We use data from current meter moorings, satellite-tracked drifters, hydrography from ships and gliders, and hig-frequency, shore-based radars to examine the time-varying circulation around Hanna Shoal, its connections to other portions of the Chukchi Sea shelf, and the circulation response to the wind field. We show that the regional flow field plays an important role in the establishment of fronts, the water mass distribution of the northeastern Chukchi Sea, and in the seasonal retreat and advance of sea ice. Each of these features plays a critical role in structuring the regional ecosystem.

*Arctic - Ecosystem Perspectives*

**The Ecological Structure Of The Northeastern Chukchi Sea: Csep Studies, 2008–2012**

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In 2008–2012, the interdisciplinary study Chukchi Sea Environmental Studies Program studied the ecology of the northeastern Chukchi Sea during the open-water season. Physical and ecological phenology differed dramatically among years, with years of early ice melt (“warm years”) in 2009–2011 and years of late ice melt (“cold years”) in 2008 and 2012. The northward flow of Bering Sea Water is a major source for heat, plankton, and fishes; it is restricted to the vicinity of the Central Channel in cold years but spreads over much or all of the northeastern shelf in warm years. Meltwater often lies at the surface over Hanna Shoal, creating a pool of cold, often poorly productive water; it is more widespread at the surface in cold years than warm years. The pool of Winter Water on the bottom structures benthic communities and, consequently, affects the distribution and abundance of benthic-feeding marine mammals; it lies to the southeast of Hanna Shoal. Questions about large-scale patterns affecting the northeastern Chukchi include the importance of northward flow of Bering Sea Water in structuring these interannual differences in zooplankton and other communities, reasons for the poor abundance of pelagic fishes throughout the area, and temporal changes in the abundance of large zooplankters that seabirds and cetaceans consume.

*Arctic - Ecosystem Perspectives***Tracking Physical Drivers And Ecosystem Response In The Pacific Arctic Through The Distributed Biological Observatory Change Detection Array****Jacqueline Grebmeier**, jgrebmei@umces.edu

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Seasonal sea ice duration and extent and seawater temperatures are critical factors driving biological processes and marine ecosystem structure in the Arctic. Biological systems clearly can be expected to respond at different time and space scales to these environmental changes. In the Pacific Arctic high productivity water column and benthic areas that are annually persistent and seasonally consistent can be termed “hotspots,” where organic carbon cascades efficiently to marine mammals and seabirds. Identifying and collecting key prey-predator biological data in the context of high priority physical and chemical measurements will allow for integration of these data into further community analyses and ecosystem modeling efforts. System level questions that could be addressed through the DBO include how will decreasing seasonal sea ice cover and warming seawater impact lower trophic prey populations and their ability to support upper trophic predators, such as marine mammals and seabirds? Can we evaluate the interannual seasonality of the biological responses to patterns of sea ice retreat and associated hydrography by observing biogeochemical and biological parameters over periods that have significantly different sea ice regimes? In order to more systematically track broad biological responses to changing physical drivers, a cooperative effort by scientists in the Pacific Arctic Group (a consensus-driven international consortium working in collaboration with the marine working group of the International Arctic Science Committee) have implemented the Distributed Biological Observatory (DBO). A series of coordinated, multi-trophic level observations include select physical, biogeochemical and biological measurements along five biologically significant transects in the Pacific Arctic. Seasonal measurements are made simultaneously with hydrographic surveys, satellite observations, and biophysical moorings. Data archiving of DBO results from both national and international participants through a common portal is being developed. This presentation will highlight results at all 5 DBO sites from 2010-2013 in relation to retrospective and ongoing process-oriented studies in the region. Further information on the DBO and biological time series changes in the Pacific Arctic region can be found at the following website: <<http://www.arctic.noaa.gov/dbo>>.

*Arctic - Ecosystem Perspectives***Results from the Pacific Marine Arctic Regional Synthesis (PacMARS)**

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The Pacific Marine Arctic Regional Synthesis (PacMARS) is a research synthesis effort funded through the North Pacific Marine Research Board that is developing an up-to-date understanding of the Pacific-influenced shelf ecosystems of the Arctic Ocean, including its human dimensions. The overall approach is to: 1) identify and synthesize relevant data sets and natural and social science studies in research areas that include physical oceanography, marine ecology, contaminant chemistry, and human adaptation, and 2) define the high-priority, overarching scientific themes and research needs for the next decade or more of marine ecosystem studies in the Pacific Arctic Region. This effort includes compiling the best available knowledge from local communities, peer-reviewed social and natural sciences, as well as to document less readily available sources, e.g. gray literature and traditional and local knowledge. The PacMARS synthesis effort is structured to address uncertainties in knowledge and to summarize what is already known. Community meetings were held in Savoonga, Gambell, Nome, Kotzebue, and Barrow in 2013 during which members of the PacMARS project consulted with representatives of coastal communities within the study region, including discussing the emerging questions important for the understanding of arctic ecosystems from researcher and community perspectives. The assembled data and other synthesis products resulting from project efforts have been transferred to the National Center for Atmospheric Research's Earth Observing Laboratory (EOL; <http://arctic.eol.ucar.edu>) and will be publicly accessible by the time the final report for this project is submitted in June 2014. These data sets form the foundation for a suite of planned peer-reviewed synthesis publications. In this presentation, we provide examples of synthesis activities undertaken, and resulting products. We discuss the challenges and data limitations that need to be overcome to address the myriad research and practical needs of this region in the context of changing environmental conditions. Ultimately, we hope that our contribution will facilitate effective management and promote sustainable use of marine resources, from subsistence use to commercial fisheries to commercial exploration and development.



*Bering Sea - Climate and Oceanography*

**Coupled Wind-Forced Controls Of The Bering-Chukchi Shelf Circulation And The Bering Strait Throughflow: Ekman Transport, Continental Shelf Waves, And Variations Of The Pacific-Arctic Sea Surface Height Gradient**

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We present a conceptual model of the closely co-dependent Bering shelf, Bering Strait, and Chukchi shelf circulation fields by evaluating the effects of wind stress over the North Pacific and western Arctic. Bering Strait transport anomalies are set by the longitudinal location of the Aleutian Low, which drives oppositely signed anomalies at synoptic and annual time scales. Synoptic scale variations result from local wind forcing and remotely generated continental shelf waves, whereas annual scale variations are driven by basin adjustments to wind stress. In particular, we show that storms centered over the Bering Sea excite continental shelf waves on the eastern Bering shelf that carry velocity anomalies northward through Bering Strait and along the Chukchi coast. Storms over the Bering Sea also tend to decrease the northward Bering Strait transport at annual to decadal time scales by imposing cyclonic wind stress curl over the Aleutian Basin and the Western Subarctic Gyre: Ekman suction then increases the water column density through isopycnal uplift, thereby decreasing the dynamic height, sea surface height (SSH), and Pacific-Arctic pressure head. Storms displaced eastward over the Gulf of Alaska generate an opposite set of Bering shelf and Aleutian Basin responses. Over the western Chukchi and East Siberian seas, anticyclonic winds of the Beaufort High promote coastal divergence, which also increases the Pacific-Arctic pressure head and generates shelf waves that impinge upon Bering Strait from the northwest.

*Bering Sea - Climate and Oceanography***Mean Currents on the Bering Sea Middle Shelf- M2, M4, M5, M8**

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While the long term means of currents on the middle shelf of the Bering Sea (measured at M2, M4, M5, and M8) are very weak, (<1cms-1), there are significant patterns at both seasonal and storm scales. These patterns differ at each mooring. At M2, “summer” surface currents (15 May-15 September) are largely wind-driven. However, during the “winter” (1 November-1 April) bottom currents significantly modify the current structure. Winter currents, which provide paths of transport for heat, nutrients, zooplankton and larval fish, tend to parallel the Alaska peninsula. At M4 it is the summer during which currents deviate from being purely wind-driven. Significant southward bottom flow dominates the flow top to bottom during this time. This southward flow is likely related to the anti-cyclonic flow observed around the Pribilof Islands and likely advects zooplankton and larvae southward. At M5, the currents are largely dominated by the wind in both summer and winter. Summer currents at M8 are very weak. In the winter, before ice covers the site, currents there are strongly baroclinic, with dominantly westward flow unrelated to winds. This westward flow likely brings colder water and helps advect ice over the site. Only after ice covers M8 does the wind dominate the currents. These north-south differences in currents on the middle shelf have implications for sea ice cover, water column structure, water temperature, and salinity (including nutrients), and for the transport of zooplankton and larval fish.

*Bering Sea - Climate and Oceanography*

**Choosing And Using Climate Model Projections For An Aleutian-Bering Sea Vulnerability Assessment**

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This talk will introduce recent developments in modeling the coupled climate-ocean system in the Bering Sea and Aleutian Islands and discuss several output variables of particular interest to researchers and managers who are attempting to better understand climate impacts and assess vulnerabilities of resources and human communities in the region. New information to be presented includes downscaled outputs from the most recent generation (CMIP5) of global climate models for the mid-21st century. Results include but are not limited to temperature, precipitation, sea ice, winds, storms and other extreme events as derived from regional climate modeling (dynamical downscaling). Downscale methods and relative uncertainty across different output variables will be described in the context of climatic variability. Efforts to integrate climate information into whole-system models of ocean response will also be highlighted to illustrate applications of a single climate model on physical oceanography and productivity. The purpose of this plenary talk is to provide a summary of the best available climate science for the region, as well as its capabilities and limitations, so that the practitioner community can become better informed about the current state of climate projections.

*Bering Sea - Climate and Oceanography***Acidification-Induced Carbonate Mineral Dissolution In The Eastern Bering Sea**

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The Eastern Bering Sea is a dynamic region that has undergone significant changes in the character of the ecosystem during the past several decades in response to global change processes. This transition has been delineated by declines in Arctic species, while more temperate populations have taken their place. Of particular concern is that the ecosystem may shift to an alternative state, with unknown consequences for commercial or subsistence fisheries. New evidence suggests that the accumulation of anthropogenic carbon dioxide may be one of the leading drivers of change, particularly in the benthic environment where species that are sensitive to ocean acidification (OA) dominate. The intrusion of carbon dioxide emitted from human activities is already causing some carbonate mineral dissolution in areas of the southeastern Bering Sea Shelf. The dissolution of carbonate minerals could have a negative impact on economically important organisms in the region by inhibiting the production and maintenance of carbonate shells and tests. Here, we use recently collected data from a variety of platforms to identify the natural sources of seasonal carbon dioxide accumulation that precondition these areas to exhibit uniquely enhanced vulnerability to OA. These data provide new insights into late-season biogeochemical processes and the impact of seasonal sea-ice coverage on the regional carbon system. We show that OA amplifies the effects of natural physical conditions and respiration processes by increasing the intensity and lengthening the duration of carbonate mineral undersaturation events, indicating that anthropogenic perturbation to the carbonate system likely induces most of the observed carbonate mineral dissolution. Presently, we expect that the most intense carbonate mineral dissolution is limited to bottom waters in cold, slow-moving, highly productive, ice-covered areas of the northern shelf. However, our projections of continued OA in the Bering Sea indicate that these conditions will persist in the next decade and will likely cover the entire continental shelf region within the next 100 - 200 years.

*Bering Sea - Lower Trophic Levels*

**Primary Production, Physical Drivers And Potential Impacts On Fisheries In The Eastern Bering Sea**

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The timing and magnitude of seasonal productivity in subarctic ecosystems can strongly influence the amount of energy that travels through the ecosystem from phytoplankton to zooplankton to fish. The timing of spring productivity (ice algae and phytoplankton) is related to sea ice coverage and retreat and set up of stratification, which in turn can impact zooplankton productivity and growth. Summer primary productivity sustains zooplankton productivity and can impact food resources for fisheries on the eastern Bering Sea shelf. Summer and fall productivity on the shelf is affected by vertical stability in the water column and wind events which impact vertical movement of nutrients to the surface waters. In fall the reduction of light due to vertical mixing of the water column marks the end of the growing season. To assess the relationship between primary production, physical drivers and potential impacts on fisheries, we compare available primary production data, length of winter (termed period when phytoplankton prey are unavailable for secondary producers), summer stratification and wind events, surface nutrient concentrations, zooplankton abundance and age 0 pollock size and energy content over recent years (2003-2011). Preliminary results suggest that high summer stratification and few wind mixing events can lead to lower primary production, lower silicate and reduced size for age-0 Pollock in the eastern Bering Sea.

*Bering Sea - Lower Trophic Levels*

**The Spatial Distribution Of Euphausiids And Walleye Pollock In The Eastern Bering Sea Does Not Imply Top-Down Control By Predation**

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Although euphausiids of the genus *Thysanoessa* ('krill') are a key zooplankton taxon in the Bering Sea ecosystem, the processes controlling variation in the standing stock of these animals are not well understood. Both forcing by temperature ('bottom up') and predation ('top down') has been proposed. The relative importance of these alternative explanations is important to our conceptual model of how the Bering Sea ecosystem functions now, and how it may change in the future. We developed multivariate regression models to examine the spatial distribution of euphausiids and walleye pollock (*Theragra chalcogramma*, their single most important predator in the Bering Sea), using acoustic and trawl survey data collected in six summers from 2004 - 2010. Our hypothesis was that if strong top-down control dominated, there would be a strong negative relationship between the standing stocks of these animals. We used the models to evaluate the relative importance of pollock biomass and water temperature in predicting euphausiid biomass, and found that temperature was a far better predictor. This result is not consistent with dominant top-down control of euphausiids by predation.

*Bering Sea - Fish and Fish Habitat***Spatial And Temporal Analysis Of Dispersal Pathways In Slope-Spawning Flatfish In The Eastern Bering Sea**

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When adult spawning and juvenile settling locations of marine fishes are geographically separated, early life history stages must rely on transport and their own behavior to move them toward suitable habitats for successful recruitment to the juvenile phase. Despite similar spawning times, locations, and depths, Greenland halibut (GH, *Reinhardtius hippoglossoides*) and Pacific halibut (PH, *Hippoglossus stenolepis*), two commercially-important flatfish species in the eastern Bering Sea (EBS), exhibit distinct differences in the distribution and abundance of their egg, larval, juvenile, and adult stages, as well as their overall population dynamics. Mechanisms that drive these species-specific differences are unknown, however slight variations in their spawning times and locations, variations in their intrinsic pelagic larval durations (PLD) and vertical distributions, and/or variability in their ability to utilize ocean currents likely influence their dispersal pathways. To understand the physical mechanisms of larval delivery to shelf nursery areas, we simulated GH and PH dispersal pathways from their source (e.g., spawning areas over the continental slope) to settlement locations (e.g., juvenile nursery areas over the continental shelf) using DisMELS (Dispersal Model for Early Life Stages), an individual-based particle tracking model developed to provide flatfish recruitment forecasts in the EBS. Eggs were released at 32 spawning locations in Bering Canyon at four-day intervals over the spawning season (Nov.2nd – Feb.26th) in years representing good and bad settlement success for each species. Eggs and larvae were tracked daily for the length of their PLD, 270 and 200 days for GH and PH, respectively. Dispersal corridors of successfully settling larvae, those which encountered pre-defined settlement areas during their competent-to-settle period, were compared over contrasting years, as well as between species. Local oceanographic and atmospheric conditions were also examined to explain variability in dispersal corridors. In general, GH connected with shelf nursery areas via more northern corridors, while PH connected via more southern ones, though corridor use varied between years for both species. Spawning time and location, along with climate-induced changes in circulation, appear to differentially affect GH and PH dispersal pathways and their potential recruitment to the juvenile phase.

*Bering Sea - Fish and Fish Habitat*

**Eastern Bering Sea Canyons: Unique Habitats?**

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The eastern Bering Sea outer shelf and upper continental slope habitats support some of the world's most productive fisheries. Several of the world's largest submarine canyons incise the eastern Bering Sea shelf break including Bering, Pribilof, Zhemchug, Pervenets and Navarin canyons. The North Pacific Fisheries Management Council (NPFMC) recently received testimony to protect coral, sponge and other benthic habitat of fish and crab species for two of these canyons; Pribilof and Zhemchug. To address the question of unique canyon properties we examined the role of canyons in the eastern Bering Sea using the Alaska Fisheries Science Center groundfish bottom trawl survey data, testing the hypothesis that survey catch data identifies canyons as unique habitats. We applied a host of linear, multivariate and non-parametric analysis to the data focusing on unique habitats along the slope as identified by fish and invertebrate distribution, abundance and several diversity indices. Results showed little evidence of canyons being unique habitats when compared to adjacent slope areas; however there were strong depth and latitudinal components to the faunal distribution. The major gradients structuring the communities of fish and invertebrates on the eastern Bering Sea slope appear to be depth and latitude, rather than the presence or absence of submarine canyons. Presented will be the latest analysis of the survey trawl data focusing on diversity indices with respect to the canyon areas.



*Bering Sea - Fish and Fish Habitat*

**Effects Of Ocean Acidification On Embryo Development And Fecundity In Tanner Crab, *Chionoecetes Bairdi*.**

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Anthropogenic burning of fossil fuels is causing an increase in the carbon dioxide concentration in both the atmosphere and oceans. This has caused the pH of the oceans to drop about 0.1 pH units since the start of the industrial revolution and a further decrease of 0.3 units is likely by the end of the century. This change in pH, or ocean acidification, is expected to affect marine animals and communities with calcifying species expected to be particularly vulnerable. We tested the effects of decreasing pH on embryogenesis and fecundity in Tanner crab, *Chionoecetes bairdi*. Ovigerous Tanner crabs with newly extruded embryos were captured in the Gulf of Alaska and held at ambient (8.0), 7.8, and 7.5 pH waters throughout embryo development. Embryos were sampled monthly and measured using digital micrographs. Hatch timing and fecundity were determined by quantifying larval output throughout larval release. After hatching, females were allowed to mate and extrude a second clutch of embryos and the experiment was repeated for a second year. Embryo size at the end of the first year was slightly higher with decreasing pH. At the end of the second year, most of the embryos that developed in pH 7.5 waters failed to hatch, resulting in a decrease in fecundity. Hatching failure was also observed in the other treatments to a lesser degree. Results indicate that at a lower pH there is an increase in hatching failure, however hatching failure among all the treatments lends this result inconclusive. Overall project results suggest that ocean acidification may have a negative impact on the Tanner crab population.

*Bering Sea - Fish and Fish Habitat*

**Cooperative Research To Develop New Trawl Footrope Designs To Reduce Mortality Of Tanner And Snow Crabs (*Chionoecetes Bairdi* And *C. Opilio*) Incidental To Bering Sea Bottom Trawl Fisheries**

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The mortality of crabs encountering bottom trawls has long influenced management of both Bering Sea groundfish and crab fisheries. NPRB Project 711 provided estimates of mortality rates for crabs that encounter, but escape, trawls and showed how these mortalities could be greatly reduced by slightly raising the trawl components (sweeps) that affect such crabs. The current project applies similar methods and resources to design and test changes to trawl footropes, the other major trawl component that crabs encounter, to reduce the remaining mortality of crabs due to trawling. Crabs encountering trawl footropes can either escape or be caught in the trawl net. As many more of the captured crabs die, sending more crabs under the footrope can reduce crab mortality. Because current footrope designs already capture a low proportion of crabs, other improvements will be needed that reduce damage to those escaping crabs. Working cooperatively with Bering Sea trawl captains to ensure practicality and relevance to their commercial fishery, new footrope design concepts were developed and tested. Using previously developed auxiliary nets fished behind the footrope and a validated Reflex Action Mortality Predictor (RAMP) for *Chionoecetes* spp. we were able to estimate both bycatch and escape mortality for crab and escape rates for commercial fish species. Four different footrope configurations were tested. Two configurations were tested with and without the use of artificial light. Crab bycatch appeared to be more a function of how the fishing line was rigged in relation to the footrope, than the footrope configuration itself. Lower positioning of fishing line increased crab bycatch. Crab escape mortality was reduced with larger bobbins and wider spacing. Commercial fish species escapement was surprising low given the seafloor clearance created by the larger more widely spaced bobbins. This information has been presented to Bering Sea trawl captains, so they can incorporate it into their fishing operations. Additionally, we are incorporating Bering Sea trawl captain's, fisherman, and representatives into the continued testing of the footropes at the Flume Tank in St. John's Newfoundland in November of 2013.

*Bering Sea - Fish and Fish Habitat*

**Size-Selective Survival Of Kvichak River, Bristol Bay, Alaska Sockeye Smolts in relation to smolt characteristics, ocean conditions, and sockeye productivity**

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The Kvichak watershed in Bristol Bay Alaska once supported the largest sockeye population in the world. In peak years, Kvichak River sockeye represented more than 50% of total sockeye salmon returning from the North Pacific Ocean, but beginning in the 1990s, the abundance of Kvichak River sockeye declined substantially. It was classified as a Stock of Concern until 2013. Survival of salmon in the ocean is believed to be size-selective such that larger, faster growing fish are more likely to survive. However, little is known about how size-selective survival of Kvichak River sockeye salmon (and other salmon) varies over decades in response to ocean conditions and climate shifts. To estimate size of surviving Kvichak River sockeye smolts size, we developed a smolt length/scale radius regression from juvenile salmon scales and back-calculated size of age-1 and age-2 smolts from adult sockeye scales, 1955 to 2008. Size of surviving smolts was compared with observed smolt size entering Bristol Bay, and the degree of size-selective survival was estimated for each smolt age and adult age group during the 54 year period. We examined potential fyke net avoidance by larger age-2 smolts during the past five decades but found little evidence that avoidance might bias patterns of size-selective survival. Size of surviving smolts after 2-3 years at sea did not shift over time, but selectivity was greater after the mid-1970s regime shift in response to smaller smolts leaving freshwater. Analyses indicated selectivity was higher in abundant sockeye smolt years, perhaps reflecting early marine density-dependent growth and survival. Selectivity was correlated with age-0 pollock abundance in the southeastern Bering Sea possibly because larger sockeye smolts can eat larger, more energetic juvenile pollock, which provide a highly important prey for juvenile sockeye salmon in warm water years.

*Bering Sea - Seabirds***Seabird Indicators Of Alaskan Ecosystems: Regionalization And The Use Of Reverse Inference To Predict Forage Fish Abundance**

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The Alaska Maritime National Wildlife Refuge (AMNWR) leads long-term, multi-decadal population monitoring studies of ~19 breeding seabird species at ~20 colonies throughout Alaska. As seabirds are conspicuous, and often closely track the temporal environmental variability that drives changes in regional food webs, the Alaskan seabird monitoring network provides an unparalleled opportunity to investigate the role of seabirds as indicators of ecosystem transitions over large (basin-wide) spatial scales. Breeding success (no. young breeding pair<sup>-1</sup> year<sup>-1</sup>) is the most common currency measured for seabirds globally, as well as in Alaska, and has been shown to vary predictably with prey abundance, typically in a sigmoidal or log-linear fashion (Cury et al. 2011 Science). Using a subset of the extensive AMNWR database, we investigated the use reverse inference to hind-cast forage fish abundance in Alaska LME over the past 30 years. We first evaluated the covariance in breeding success (and phenology) of 4 common species (common and thick-billed murres and black-legged and red-legged kittiwakes) from 14 colonies, and then combined datasets when appropriate using Principal Components Analysis (PCA). Missing values from these sites were estimated using multiple imputation. Based on the estimated covariance, combining genera (e.g., *Uria* murres with *Rissa* kittiwakes) was not found to be appropriate, but six colonies in the Bering Sea - Aleutian Islands (BS-AI) ecosystem showed a high level of covariance and thus could be combined to provide a regional perspective. We then used the first Principal Component to derive an integrative time series of murre or kittiwake “productivity”, and subsequently coupled these indicators with the non-linear equation of Cury et al. (2011) to predict surface (kittiwake) and sub-surface (murre) variation in forage fish abundance. By regionalizing the seabird “seascape” and linking these results to well-established numerical response relationships, we provide a unique perspective on food web dynamics, particularly for the BS-AI ecosystem, which complements traditional acoustic-trawl survey methods for monitoring epipelagic forage fish populations in Alaska. The pros and cons of this approach are discussed.

*Bering Sea - Seabirds***Living On The Edge— A Seabird Odyssey Among Four Alaska Marine Ecosystems****John Piatt**, [jpiatt@usgs.gov](mailto:jpiatt@usgs.gov)

Kittlitz's Murrelet, a small seabird in the auk family, evolved in Beringia during the early Pleistocene and thrives in icy-cold environments. Present-day breeding populations are associated with glaciated coastal areas of the Gulf of Alaska (GOA) and Bering Sea. During summer, murrelets nest in these areas and lay a single egg on bare rocks on alpine mountain slopes up to 2500 m in elevation and 70 km inland. Nest-bound adults forage away at sea on energy-rich prey such as sand lance, capelin and krill, typically in cold or glacially-modified marine waters where such prey are abundant. Satellite tagging and isotopic diet studies suggest that after breeding, murrelets from the GOA migrate up to 3500 km into the Bering, Chukchi and Beaufort seas, probably in search of fatty forage fish to sustain a flightless molt and lay on fat reserves for winter. Many murrelets then overwinter in polynyas or along the sea-ice edge of the Bering Sea. Compared to other alcids, murrelets have a more limited capacity to buffer against food shortages, and the annual odyssey of Kittlitz's murrelets among extremely cold terrestrial and marine environments must be challenging. As a cold water specialist, how have they fared during recent warm climate cycles? Evidence suggests that as water temperatures warmed in the GOA and Bering Sea after the 1976 regime shift, murrelet populations declined markedly until the mid- 2000s. These declines coincided with large-scale changes in biogeography of forage species in the GOA and Bering Sea that were in turn linked with multi-decadal climate cycles. Effects may resonate across seas and seasons. For example, the decline of murrelets in Prince William Sound between 1989 and 2007 is strongly correlated with an increase in average trophic level and northward spatial displacement of fish communities on the SE Bering Sea shelf. As conditions have returned to normal (cold) in the SE Bering Sea and GOA, murrelet populations in PWS are increasing again for the first time in 30 years. In any case, it appears that murrelet population dynamics depend on their foraging success in four different marine ecosystems of Alaska.

*Bering Sea - Seabirds***Preliminary Results Of Of An Experimental Study Of Geolocation Tag-Effects On Parakeet And Whiskered Auklets**

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Auklets are the numerically dominant seabirds breeding in Alaska, but little is known about their behaviour outside of their short breeding season. Winter movement and behaviour at sea are often cited as key missing pieces of information when evaluating effects of natural and anthropogenic factors on seabird populations. Among auklets, Parakeet auklets (*Aethia psittacula*) are believed to disperse most widely, and Whiskered auklets (*Aethia pygmaea*) are thought to be year-round Aleutian residents, wintering close to breeding sites. Recent innovations have led to development of light-based geolocation tags light enough to deploy on small seabirds, but to ensure biological relevance of resulting data we need to evaluate any potential effects of the tags themselves. In 2012 we deployed LOTEK LAT-2900 2g geolocation tags (total attachment 1.3% body mass) on Parakeet auklets breeding at Buldir Island, Alaska. In 2013 we used new MIGRATE TECH 1g tags (total attachment 0.75-1.3% body mass) on Parakeet (N = 16 1g tags; 19 2g tags) and Whiskered auklets (N = 23 1g tags). We found no difference in fledging success between tagged and control birds for either species, and similar adult return rates for Parakeet auklets. In 2012 we found no negative impact on the growth rates of chicks from tagged Parakeet auklet nests. However in 2013 there were indications of delayed growth and later fledging in both species. Chick growth rates across all treatments in 2012 were greater than measurements from Buldir in 1991, and fledging success was above average, suggesting that food was abundant that year. In 2013, however, fledging success was the lowest since 2004 for both species. All of the 11 LOTEK 2900 tags recovered in 2013 malfunctioned and no useful data were obtained. With small sample sizes, our results suggest that although light-weight geolocation tags can be a valuable tool in the study of these and other seabird species, the typical guideline of 3-5% body mass for tracking tags may be inadequate for some species, and even birds that show no effects from tagging in a good year, might be unable to compensate in a bad year when resources are scarce.

*Bering Sea - Seabirds***Overlapping Shipping Traffic And Seabirds In The Aleutian Archipelago: A Seasonal Risk Analysis**

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Some of the largest seabird concentrations in the northern hemisphere are intersected by a major shipping route through the Aleutian Archipelago (AI) of Alaska. Using data from the North Pacific Pelagic Seabird database and integrating bathymetric features and oceanographic characteristics we build a seasonally explicit predictive model of seabird distribution in the archipelago, using random forests. We fit one model for each of ninety seabird/waterbird species recorded in the database within 500 km of the AI. Colony-effect, sea surface temperature, and month are the most important variables in the random forest models. Combined seabird abundance peaks in August, with major concentrations around Unimak Pass in the eastern AI, and along the continental shelf edges. During the summer, the avian community is dominated by short-tailed shearwater (*Puffinus tenuirostris*), a migrant that breeds in the southern hemisphere. Their abundance drive the seasonal patterns of seabird densities. We multiply seabird densities with a published oil vulnerability index for each species, thus obtaining seasonal maps of oil vulnerability. To assess risk, we combine this vulnerability index with an index of shipping vessel traffic density. Shipping density is our proxy for the probability of a shipping accident at a particular location and time. The risk of shipping incidents to seabirds is greatest where a high likelihood of an incident coincides with high vulnerability (and concentrations of seabirds). Depending on the season, we identify high-risk areas around Unimak Pass (eastern AI; the main pass), on the south-side of the Alaska Peninsula, and through two passes in the western AI - the north side of Attu, and near Buldir Island. Of these sites, the risk is highest (high bird vulnerability and high traffic density) in Unimak Pass and south of the Alaska Peninsula. Our results can be used for defining marine protected areas, proactive planning of shipping routes and staging of response resources, and as a management tool in the event of a shipping accident.

*Bering Sea - Mammals***Bering-Okhotsk Seal Surveys (BOSS): Joint US-Russian Aerial Surveys For Ice-Associated Seals, Spring 2012 And 2013.**

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Scientists at NOAA's National Marine Mammal Laboratory collaborated with colleagues from the State Research and Design Institute for Fishing Fleet ("Giprorybflot") in Russia, to conduct synoptic aerial surveys of ice-associated seals (bearded, spotted, ribbon, and ringed seals) in the Bering and Okhotsk Seas in spring 2012 and 2013. US survey flights originated from airports in Nome, Bethel and Dillingham, AK and utilized airstrips in Gambell, on St. Lawrence Island, and St. Paul, in the Pribilof Islands, to reach remote areas of the central Bering Sea. The Russian team began surveys of the Sea of Okhotsk from Khabarovsk in Tatar Strait, working their way through Shelikhov Bay and into Karaginsky Bay. Surveys of the western Bering Sea started in Ossora, on the Kamchatka Peninsula, and continued north to the Bering Strait. Most US flights were at an altitude of 1,000 ft (300 m). A NOAA Twin Otter carried three FLIR SC645 thermal imagers that recorded continuous data in the 7.5-13.0  $\mu\text{m}$  wavelength. Each thermal imager was paired with a digital single-lens reflex (SLR) camera with a 100-mm lens. The combined thermal swath width was approximately 1,500 ft (470 m). A second US aircraft (Aero Commander) carried two sets of paired instruments, providing a swath width of approximately 900 ft (280 m). The two US aircraft flew more than 31,000 nautical miles (57,400 km) during 75 surveys, and collected more than 1.8 million SLR images. The Russian aircraft (AN-38 Vostok) flew more than 12,000 nmi (23,000 km) during 32 surveys with similar instruments that provided a thermal swath width of approximately 2460 ft (750 m) at an altitude of 820 ft (250 m). The thermal imagers detect the warm bodies of seals against the background of the cold sea ice, and the high-resolution digital images help to identify the seal to species. The seal counts will be used to produce the first comprehensive estimates of abundance for the four species of ice-associated seals found in the Okhotsk and Bering seas, accounting for multiple sources of uncertainty including detection rates; seal haul-out behavior; species identification; and changes in ice extent and distribution.



*Bering Sea - Mammals***Cost-Benefit Ratios Of Foraging Trips For Northern Fur Seals****Tiphaine Jeanniard-du-Dot**, dudot@zoology.ubc.ca

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The ratio between energetic costs for obtaining food and energy required by animals to meet their daily needs impacts survival and reproduction. This cost-benefit ratio is a cornerstone parameter of many biological studies, but requires accurate measures of at-sea metabolic rate and energy gain. Our goals were to 1) develop models that better predict the at-sea metabolic rates of northern fur seals (NFS), 2) assess energy gained while foraging, and 3) determine the cost-benefit ratio of their foraging trips. Twenty lactating females were injected with doubly-labeled water (to estimate metabolic rate) and carried GPS-TDR and accelerometers. We recorded morphometric measurements before and after foraging trips, and calculated Overall Dynamic Body Acceleration (ODBA), flipper stroke count while diving, dive parameters, and time-activity budgets (i.e. time spent resting, diving, or travelling fast or slow). We also used acceleration data to determine prey capture attempts, and estimated ingested energy from diet information. From these data, we calculated the cost-benefit of each trip. Results from generalized least square (gls) models showed that neither ODBA nor flipper stroke count alone could accurately reflect energy expenditure of fur seals at sea. The best predictors came from a multivariate model including time spent at sea, dive rate, ODBA and species. Time-activity budgets also influenced energy expenditure. Energy consumed was based on our estimates of number of prey consumed per night of foraging (~200 prey per seal consisting mostly of juvenile pollock). Comparing estimates of energy intake with estimates of at-sea energy expenditure to determine the cost-benefit ratio of foraging trips provides a strong foothold for further energetics-based studies on pinnipeds, as well as information about prey consumption and requirements needed to make conservation and management decisions.

*Bering Sea - Mammals***A Little SNP Of This, A Little SNP Of That: Development Of SNP Chip Array To Enable Rapid Identification Of Individual Pacific Walrus**

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Recent technological advances in molecular genetics have enabled whole- or reduced-genome scans of non-model organisms to be achieved in mere days. The rapid generation of gigabytes of data allows investigators to efficiently seek highly informative molecular markers that can be used for individual identification as well as estimating population abundances and demographic rates. Genetic monitoring via molecular markers, such as microsatellites (MSAT) and/or single nucleotide polymorphisms (SNP), can also be achieved without ever capturing and physically tagging an animal. A genetic tagging technique has recently been proposed for conducting a range-wide Capture-Mark-Recapture (CMR) study of the Pacific walrus (*Odobenus rosmarus divergens*). The amount of sea ice habitat available to Pacific walruses has declined over the last 30 years as a result of global climate change. This trend is projected to continue and is predicted to cause a population decline. Consequently, the Pacific walrus is a candidate species for listing under the Endangered Species Act. To further the genomic understanding of Pacific walruses, a non-model organism, and support a genetics-based CMR project we subjected nuclear DNA from 36 walruses (18 male, 18 female) to high-throughput massively parallel sequencing reactions on multiple next generation sequencing (NGS) platforms. By leveraging access to and experience with a suite of NGS platforms and bioinformatic protocols, a suite of high quality SNP have been identified that enable rapid identification of individual Pacific walrus. The discovery, validation, and conversion of walrus SNP assays have also afforded us the opportunity to directly compare their utility against working MSAT within a CMR context. Though we have no reason to believe the current panel of optimized MSAT is unsuitable for our purposes we are cognizant of the need to analyze thousands of samples in relatively short periods of time. Given the high-throughput capacity of today's fluidic qPCR platforms, the creation and implementation of walrus SNP chip arrays will expedite our ability to accurately discriminate individuals while reducing the probability of genotyping errors and providing greater resolution of the structure, size, and demographic rates of this species.

*Bering Sea - Humans***Combining Community-Based Observations And Satellite Imagery To Describe The Local And Regional-Scale Sea Ice Conditions Relevant To Bearded Seals And Walrus In The Bering And Chukchi Seas**

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Changing sea ice conditions can have profound effects on marine ecosystems and subsistence hunting communities that depend on marine resources. Negative ice anomalies have been correlated with more favorable hunting conditions in the Bering Sea, but the duration of favorable spring ice conditions is also important as demonstrated by the dramatically lower spring harvest in 2013 in Gambell and Savoonga that some community members attributed to a rapid spring ice retreat. Given the complexity of marine mammal responses to a changing environment, it is often useful to leverage the observing capacity of local experts. We analyzed observations from April 2006 to July 2013 by indigenous sea ice experts in Barrow, Shishmaref, Wales, Gambell, and Toksook Bay, Alaska to (1) examine associations of migrating walrus and bearded seals with local and regional sea ice conditions, and (2) detect changes in the timing of the spring walrus migration from the perspective of subsistence hunting activities. Community observations were obtained from the Seasonal Ice Zone Observing Network (SIZONet) database (<http://eloka-arctic.org/sizonet/>) and the Sea Ice for Walrus Outlook, SIWO (<http://www.arcus.org/search/siwo>). SIZONet brings together geophysical methods of monitoring and studying Alaska's coastal and shorefast sea ice with observations and knowledge from local sea ice experts, and SIWO is a collaborative project that ties spring sea ice forecasts with local observations of sea ice and weather conditions. By relating community-based observations of sea ice, walrus and bearded seals with MODIS and AVHRR satellite imagery we found that walrus were more sensitive to the persistence of sea ice in Bering Strait during the spring migration compared to bearded seals. We did not detect any changes in the timing and location of migrating walrus from March to July when we compared current observations with previous reports from 1970 and earlier. Our results suggest that despite the potential bias of hunters' observations of walrus and bearded seal distributions with respect to distance from coast and favorable weather conditions, there is merit to using this approach to drive new research questions on how marine mammals and subsistence hunters adapt to a changing environment.

*Bering Sea - Humans***Costs Incurred By Alaskan Sablefish, Pacific Halibut And Greenland Turbot Longliners Due To Killer Whale Depredation**

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Killer whale (*Orcinus orca*) depredation (whales stealing or damaging fish caught on fishing gear) adversely impacts demersal longline fisheries for sablefish (*Anoplopoma fimbria*), Pacific halibut (*Hippoglossus stenolepis*) and Greenland turbot (*Reinhardtius hippoglossoides*) in the Bering Sea, Aleutian Islands and Western Gulf of Alaska. These interactions increase direct costs and opportunity costs associated with catching fish and reduce the profitability of longline fishing in western Alaska. This study synthesizes National Marine Fisheries Service (NMFS) observer data, NMFS sablefish longline survey and fishermen-collected depredation data to: 1) estimate the frequency of killer whale depredation on commercial longline fisheries in Alaska; 2) estimate depredation-related catch per unit effort reductions; and 3) assess direct and opportunity costs incurred by longline fleets in western Alaska as a result of killer whale interactions. The percentage of commercial fishery sets affected by killer whales was highest in the Bering Sea fisheries for: sablefish (21.4%), Greenland turbot (9.9%), and Pacific halibut (6.9%). Average catch per unit effort reductions on depredated sets ranged from 35.1-69.3% for the observed longline fleet in all three management areas from 1998-2012 ( $p < 0.001$ ). To compensate for depredation, fishermen set additional gear to catch the same amount of fish, and this increased fuel costs by an additional 82% per depredated set (average \$433 additional fuel per depredated set). In a separate analysis with six longline vessels in 2011 and 2012, killer whale depredation avoidance measures resulted in an average additional cost of \$494 per vessel-day for fuel and crew food. Opportunity costs of time lost by fishermen averaged \$486 per additional vessel-day on the grounds. This assessment of killer whale depredation costs represents the most extensive economic evaluation of this issue in Alaska to date and will help longline fishermen and managers consider the costs and benefits of depredation avoidance, deterrent use and alternative policy solutions.

*Bering Sea - Humans***Using Vessel Monitoring System (VMS) Data To Estimate Spatial Effort In Bering Sea Fisheries For Unobserved Trips****Jordan Watson**, jtwatson2@alaska.edu

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The primary characteristics of fishing effort - how much, how often, when, and where - are critical components for estimating the impacts of commercial fishing on target and non-target species, as well as on their habitats. For vessels that target a number of North Pacific species including pollock and Pacific cod, vessel monitoring systems (VMS) transmit fishing vessel locations and times at regular intervals, capturing vessel movement behaviors (e.g., speed and turn angles). Thus, they offer an opportunity to resolve many of the uncertainties surrounding fishing effort in the absence of fishery observers. We used the eastern Bering Sea pollock catcher vessel fleet as a test case for utilizing VMS data to predict when fishing occurred. We combined VMS and 100% fishery observer coverage data from 2011 and 2012 to build generalized additive models of fishing effort. Out-of-sample model predictions of fishing and non-fishing behaviors yielded a high degree of accuracy both within and across years. Models were extended to data from 2003 - 2010 for which fishery observer coverage was 100% for a portion of the fleet and 30% for the remainder. Out-of-sample predictions for the 100% coverage vessels and for the observed portion of the 30% coverage vessels yielded similar prediction accuracies to those from 2011 - 2012. Models were then extended to the remainder of the fleet to predict fishing effort for the unobserved fishing trips. We also compared these models to speed filters that have been employed in some cases to estimate fishing effort from VMS data, finding that speed filters commonly over-estimate the likelihood that fishing occurred. We are utilizing a similar methodology to estimate unobserved fishing effort for the Pacific cod fishery in the Bering Sea and the pollock and cod fisheries in the Gulf of Alaska. Our approach demonstrates an under-utilized opportunity for VMS data, providing probabilistic estimates of fishing behavior through a framework that is applicable across multiple gear types, target species, years, and management areas.

*Bering Sea - Ecosystem Perspectives***Ocean Acidification: Perceptions, Risks and Uncertainties**

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The extremely valuable commercial and subsistence fisheries in Alaska are located in seas projected to experience rapid transitions in pH and other chemical parameters caused by ocean acidification (OA) in the coming decades. Many of the marine organisms that are most intensely affected by OA, such as mollusks contribute substantially to the state's commercial activities as well as the gross domestic product (GDP) of the United States. Prior studies of OA's potential impacts on human communities have focused on possible economic losses from specific scenarios of human dependence on harvests and damages to marine species. However, non-economic impacts due to OA are likely to also manifest, such as changes in food security or shifts in livelihoods. Here, we describe the current patterns of dependence on marine resources within the state that could be negatively impacted by OA and current community characteristics to determine the risk to Alaska's fishery sector. Our analysis showed that regions in southeast and southwest Alaska that are highly reliant on fishery harvests and have relatively lower income and employment alternatives face the highest risk from OA. Results suggest that OA merits consideration in policy and adaptation planning, as it may represent yet another challenge to Alaskan communities, some of which are already in socioeconomic decline. To determine the public awareness and understanding of this potentially game-changing threat we conducted a statewide survey to better understand the multitude of variables that influence the perceptions of the risk associated with OA, as well as environmental literacy and support for mitigation efforts. We then used this information to better understand if and how individuals react to the current variable degree of OA in different regions of Alaska. This has helped us identify where there are gaps in understanding of OA and how future OA initiatives can be implemented in order to prepare individuals, communities, and the fishing industry for future changes in ocean chemistry.

*Bering Sea - Ecosystem Perspectives***Spatial Match-Mismatch Explains Walleye Pollock Recruitment Variability Across Contrasting Climate Conditions In The Eastern Bering Sea****Elizabeth Siddon**, ecsiddon@alaska.edu

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Understanding mechanisms behind variability in early life survival of marine fishes through modeling efforts can improve predictive capabilities for recruitment success under changing climate conditions. Walleye pollock (*Theragra chalcogramma*) support the largest single-species commercial fishery in the United States and represent an ecologically important component of the Bering Sea ecosystem. Variability in walleye pollock growth and survival is structured in part by climate-driven bottom-up control of zooplankton composition. We used two modeling approaches, informed by observations, to understand the roles of prey quality, prey composition, and water temperature on juvenile walleye pollock growth: (1) a bioenergetics model that included local predator and prey energy densities, and (2) an individual-based model that included a mechanistic feeding component dependent on larval development and behavior, local prey densities and size, and physical oceanographic conditions. Prey composition in late-summer shifted from predominantly smaller copepod species in the warmer 2005 season to larger species in the cooler 2010 season, resulting in different growth conditions and year-class survival. Observed diets reflected temporal variability in zooplankton composition, corroborating hypothesized bottom-up control of survival. In 2010, the main prey of juvenile walleye pollock were more abundant, had greater biomass, and higher mean energy density, resulting in greater recruitment to age-1 compared to 2005. Spatial patterns in prey composition and water temperature lead to areas of enhanced growth, or growth ‘hot spots’, for juvenile walleye pollock and survival may depend on the overlap between fish and these areas. This study provides evidence that a spatial mismatch between juvenile walleye pollock and growth ‘hot spots’ in 2005 contributed to poor growth conditions while a higher degree of overlap in 2010 resulted in improved growth conditions. Our results indicate that climate-driven changes in prey composition and quality can impact growth of juvenile walleye pollock, potentially severely affecting recruitment variability.

*Bering Sea - Ecosystem Perspectives***Top predators partition the Bering Sea**

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We tracked the movements of seals and seabirds breeding on the Pribilof Islands (central Bering Sea) and Bogoslof Island (southern Bering Sea) to determine where these central place foragers feed relative to the constraints of distance from land, environmental conditions, and availability of food. A total of 115 northern fur seals, 128 thick-billed murres and 106 black-legged kittiwakes were equipped with GPS and activity tags in 2008 and 2009. At-sea locations showed no overlap in foraging areas for kittiwakes or murres breeding on the two Pribilof Islands despite the islands being within foraging distance of each other. Nor was there any overlap between the foraging areas for seabirds from Bogoslof Island compared to those from the Pribilofs. Foraging ranges of northern fur seals also showed segregation of feeding areas by breeding sites between and within islands. The distinct segregation of feeding areas by breeding colonies and the similarities in segregation between both groups of central place foragers implies a common set of selective mechanisms related to compass orientation of breeding colonies, competition within and between species, predation risk, and energetic constraints associated with distance, prey size and energy content. Our data suggest that immediate environmental conditions may have less effect on broad-scale habitat selection compared to colony orientation and the longer-term selective forces related to foraging costs and predictability of annual environmental conditions. This implies that existing breeding colonies in the Bering Sea may be poorly adapted and unable to respond favorably to global warming and environmental change.



*Bering Sea - Ecosystem Perspectives***What Controls Trophic Interconnectivity In The Eastern Bering Sea?**

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The Bering Sea is one of the world's most productive marine ecosystems, sustaining nearly half the U.S. annual commercial fish catch and providing food and cultural value to thousands of coastal and island residents. Seasonal sea ice is recognized as a central driver of this ecosystem, and recent changes in sea ice extent have highlighted the ecosystem's vulnerability to a dynamic climate and accompanying sea ice loss. In response, the Bering Sea Project has brought nearly a hundred principal scientists together in a vertically integrated observational and modeling program aimed at understanding the impacts of changes in seasonal sea-ice on the ecosystem, spanning physics and phytoplankton to people. The Bering Sea Project is now well into the synthesis phase, and several overarching patterns have emerged. First, winter wind direction and intensity exerts a strong and variable control on Bering Sea continental shelf circulation patterns, affecting a range of ecological processes including nutrient exchange, shelf productivity and the advection of plankton. Second, annual integrated primary production and seasonal net community production are more closely tied to seasonal meteorological forcing than to the extent of sea ice. Yet elevated primary production in warm years does not appear to increase net community production, suggesting the flow of carbon between the lower trophic levels has alternative paths yet to be quantified. Third, microzooplankton are important in the Bering Sea ecosystem—they represent important prey for larger zooplankton and during summer can consume nearly all of daily primary productivity. Fourth, pollock do not appear to exert strong top-down control on the abundance of crustacean zooplankton as hypothesized, but rather the system remains driven by bottom-up mechanisms even in years of increasing pollock biomass. Fifth, upper-trophic predators such as fur seals and seabirds, rely on small-scale prey patch characteristics, rather than broadscale distributions of biomass to perceive the quality of their food supply and the mechanisms they use to exploit it. Finally, the interactions between coastal residents and their subsistence harvests showed large local variation, underlining the complexity of the ecosystem and of the region's cultural and economic dynamics.

*Gulf of Alaska - Climate and Oceanography*

**Freshwater Discharge Into The Gulf Of Alaska - High Resolution Modeling And Practical Tools**

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A comprehensive effort to quantify coastal freshwater discharge (CFD) into the Gulf of Alaska (GOA) has been carried out. Knowledge of the spatio-temporal variation of CFD is relevant to many scientific disciplines including nearshore oceanography, aquatic ecology, fisheries science, and many others. The primary goal of this effort was to produce runoff estimates with high spatial resolution, serving a variety of end users. Four primary tasks have been accomplished. First, high resolution weather grids, necessary for the runoff estimates, have been produced using statistical downscaling methods. These grids span all of Alaska and northwest Canada. Second, regression equations that relate basic watershed physical characteristics to mean monthly flows have been developed. These equations are satisfactory in predicting the seasonal variation of discharge and can be applied to any watershed of interest. Third, a high-resolution (1 km grid, sub-daily time step) computational model that includes meteorological distribution algorithms, snow hydrology equations, and surface runoff routing has been applied to the entire GOA watershed. Model predictions of snow-water-equivalent and streamflow are found to agree well with observations. Fourth, project products are being archived and distributed in order to maximize the impact and outreach of this project. As examples, the developed weather grids have been archived at the National Climatic Data Center and an interactive tool for the exploration of weather and streamflow parameters has been developed in collaboration with AOOS.

*Gulf of Alaska - Climate and Oceanography***Variability Indeed: The Meaning Of Multiple Consecutive Anomalous Years Reflected By Glacier Bay Oceanography**

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Continuous long-term monitoring of oceanographic conditions of Glacier Bay, Alaska is entering its 22nd year. The program's purpose is to understand seasonal and interannual variability, and to detect any trends in oceanographic change. Standard oceanographic parameters (temperature, conductivity, density, light penetration, turbidity, in situ chlorophyll fluorescence, and dissolved oxygen concentration) have been characterized by vertical cast data year-round during nearly-monthly sampling cruises that include a set of 22 permanent stations. In general, parameters consistently reflect typical ranges and spatial (both horizontal and vertical) and temporal patterns expected for a high-latitude tidewater glacial fjord, with strong seasonal signals and strong length-of-fjord gradients. The water column is well-mixed in winter and strongly stratified in summer. However, 2009-2012 data from a representative station in mid-summer showed consecutive statistical anomalies (compared to the 20-year mean) in water temperature, salinity, and density. The water column in 2009, 2011, and 2012 was anomalously cold, salty, and dense while 2010 was anomalously warm, fresh, and low-density. This string of consecutive years of anomalous conditions, in both directions from the long-term mean, reflects high interannual variability of Glacier Bay waters. Depending on the year, anomalies variously match patterns observed in other northern Gulf of Alaska coastal waters - or not - suggesting response to large-scale regional physical forcing, or a reflection of more local processes. Glacier Bay's interannual variability is interpreted within the context of a dynamic tidewater glacial fjord that is nevertheless linked to climate and ocean conditions and processes of the adjacent Gulf of Alaska. Insularity and connectedness both explain Glacier Bay's oceanographic dynamic.

*Gulf of Alaska - Climate and Oceanography*

**Measuring The Pulse Of The Gulf Of Alaska: 16 Years Of Oceanographic Observations Along Seward Line, And Within Prince William Sound**

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Multidisciplinary observations along the cross-shelf Seward Line, and within nearby fjordal Prince William Sound have been reshaping our view of the Northern Gulf of Alaska since the fall of 1997. Here we report on the observations of physical oceanography, nutrients, and phytoplankton that have driven variations in zooplankton biomass and community structure over that period. Rather than systematic change, we see strings of cold and warm years driven by both large scale climate indices and local conditions. This forcing has variable impact on the zooplankton populations, for which spring-time abundances can vary by nearly 2 orders of magnitude for key species, and thereby alter overall community composition. We will describe the basic seasonal and cross-shelf patterns of these zooplankton communities, and how they are related to environmental variables using multivariate techniques. We further demonstrate how oceanographic productivity, as indexed by zooplankton biomass (particularly the *Neocalanus* copepods), is correlated to the survival of hatchery-released pink salmon from Prince William Sound.

*Gulf of Alaska - Lower Trophic Levels*

**Spatio-Temporal Distribution Of Euphausiids In The Gulf Of Alaska: A Key Component To Understanding Ecosystem Processes**

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Euphausiids, or krill, are abundant in high latitude waters such as the Bering Sea and the Gulf of Alaska (GOA). They are an important part of these cold-water coastal and pelagic ecosystems both as a prey item for many species including marine mammals, seabirds, and fish, and as an ecological link between primary production and higher trophic levels. Because of the high value of Alaskan fisheries, particularly walleye pollock, it is important to understand how varying environmental conditions will affect the abundance and distribution of important fish species. One of the key factors may be the availability of their prey, including euphausiids. The goal of this study is to create a time series of euphausiid distribution in the GOA based on summer acoustic-trawl surveys in 2003, 2005, 2011 and 2013. Euphausiid backscatter was isolated by comparing the relative frequency response at 18, 38, 120, and 200 kHz. Acoustic data were ground-truthed by comparing backscatter to Methot net catches and to video from an in-trawl camera system. Preliminary results from surveys in 2011 and 2013 indicate that euphausiid backscatter was generally higher in 2011 than 2013. Euphausiids were found in patchy distributions throughout the GOA shelf. In both years, relatively more euphausiids were observed in coastal bays and the troughs around Kodiak Island as compared to the broad, flatter areas characterizing much of the cross-shelf region. Highest backscatter was observed in Barnabas Trough during both the 2011 and 2013 surveys. Temperature was determined to be an important factor affecting abundance and distribution of euphausiids in the Bering Sea, and it is possible that a similar relationship exists in the GOA. Further analysis of these data, and the inclusion of data from 2003 and 2005 will help to further elucidate these trends.

*Gulf of Alaska - Lower Trophic Levels*

**Early Life History Phenology Among Gulf Of Alaska Fish Species: Ecological Patterns And Implications For Environmental Impacts During Early Ontogeny**

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The timing and duration of fish egg and larval occurrence in Gulf of Alaska (GOA) habitats is variable among taxonomic groups, and a high diversity of phenologies is observed among both commercially and ecologically important species. Synthesis of four decades of ichthyoplankton data from the GOA indicates that although species diversity is highest and total abundance of larvae is at a peak during spring, fish larvae occur in the plankton at all times of year. Furthermore, timing of production may range from single-batch spawning over a short period of time to the production of multiple batches of eggs that may result in an extended temporal supply of larval cohorts in the plankton. Larval size at transformation to the juvenile stage is also highly variable among species and is associated with a diverse range of larval durations in the pelagic habitat. This diversity of early life history phenologies represents trade-offs in adaptation to prevailing environmental conditions in the GOA, and associated vulnerability and resilience factors may modulate species' responses to environmental variability. For instance, water temperatures and availability of suitable zooplankton prey organisms for fish larvae vary dramatically on a seasonal scale affecting degrees of synchrony among species with optimal environmental conditions for successful growth and survival of larvae. This synchrony can be influenced by interannual variability in the oceanographic environment that affects seasonal cycles. For the numerically dominant taxa encountered in the GOA ichthyoplankton, patterns of temporal exposure to the environment are described and synthesized with respect to identifying ecological adaptation to prevailing environmental conditions, and consequent potential responses during early ontogeny to changing physical and biological conditions that may result from climate and ecosystem shifts.

*Gulf of Alaska - Fish and Fish Habitat***Responses Of Alaskan Groundfishes To Ocean Acidification**

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The Bering Sea and Gulf of Alaska support a number of the nation's largest commercial fisheries, including those for walleye pollock, Pacific cod, and a suite of flatfishes. Our goal is to evaluate the impacts of ocean acidification on the early life history stages of these critical resource species. Here we report observations from two lines of research examining: a) the effects of OA on the growth or early life stages; and b) the effects of OA on behavioral responses of walleye pollock. Eggs, larvae, and juveniles of walleye pollock and eggs and larvae of northern rock sole were reared at ambient and elevated CO<sub>2</sub> levels (to ~ 2100  $\mu$ atm). In walleye pollock, there were no significant differences in hatch rates, larval or juvenile growth rates across multiple independent trials with each life stage. As observed in other species, hypercalcification of otoliths occurred in juvenile pollock held at high CO<sub>2</sub> levels. More recent experiments with larval northern rock sole produced similar results, but suggest possible negative effects of OA in later larval stages as fish undergo metamorphosis. These results suggest a general resiliency of physiological capacity for growth in these species due to population acclimation or adaptation, while demonstrating the necessity of examining responses in multiple life stages. Elevated CO<sub>2</sub> has been shown to disrupt sensory and behavioral responses in some tropical reef fish species, even when growth was not disrupted. In a separate experiment, we examined the behavioral responsiveness of juvenile walleye pollock, 58-97 mm, to prey scent cues under elevated CO<sub>2</sub>. Baseline activity levels were not significantly different among CO<sub>2</sub> treatments, but fish reared at high CO<sub>2</sub> (> 800  $\mu$ atm) were less likely to respond to injections of prey scent cues than fish reared at ambient CO<sub>2</sub> levels (~ 400  $\mu$ atm). Future experiments are planned to examine the sensitivity of other behavioral responses in walleye pollock and provide species contrasts with Pacific cod. Such behavioral responses will be a significant determinant of how acidification affects the functioning of marine ecosystems.

*Gulf of Alaska - Fish and Fish Habitat***Movement & Survival Of Cook Inlet Sockeye & Chinook Salmon Measured Using A Marine Telemetry Array****David Welch**, david.welch@kintama.com

Major declines Chinook salmon abundance occurring over a wide range of Alaskan rivers suggests that the likely cause of the problem lies in the ocean—but with the marine phase of the life history poorly understood, questions of “where and when” significant declines are established remain unclear. As a first step to addressing these issues in Alaska, we deployed a marine tracking array in east-central Cook Inlet and in the Kenai & Kasilof Rivers, from June-August, 2013. Our study was intended to resolve the relative movement of sockeye and Chinook and identify any species-specific differences in migration depth. Maturing adult sockeye and Chinook were caught in southern Cook Inlet and tagged with acoustic transmitters (“tags”) that transmitted both the serial number of each animal and the current depth. Detection efficiency on both the marine and freshwater components of the tracking array was 100%. Animation of the detection data revealed large differences in the pattern of movement of the two species, with the Chinook migrating almost exclusively as close to shore as our instrumentation was deployed, and then “patrolling” back and forth along the nearshore for significant periods of time before river entry. In contrast, the marine distribution of tagged sockeye was much broader in the eastern third of Cook Inlet (where instrumentation was emplaced), with migration primarily occurring offshore. A lack of receivers within the first 1.5 nautical miles (2.7 km) of the eastern shore of Cook Inlet, where the east-side setnet fishery (ESSN) operates, is a significant limitation in the observational power of the current array design. However, the relative depth distribution of the two species on the receivers sited along the offshore boundary of the ESSN showed promising evidence of a significant difference in the depth of migration between the two species and can be used to assess the trade-off that would result if the maximum vertical depth of the surface-hung gillnets was reduced. Survival could also be estimated from release to the marine array, from the marine array to the river mouth, and from the river mouth to the farthest upstream components of the Kenai River sub-array.



*Gulf of Alaska - Fish and Fish Habitat***Spatial Associations And Trophic Relationships Of Skates In The Western Gulf Of Alaska**

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As ecosystem-based fisheries management gains momentum in Alaska, it is important to determine the spatial associations and trophic relationships of widespread and abundant fishes, such as skates. Our primary research objective was to determine this ecological information for the skate assemblage on the continental shelf and upper continental slope of the western Gulf of Alaska: big skate (*Raja binoculata*), longnose skate (*R. rhina*), Alaska skate (*Bathyraja parmifera*), Aleutian skate (*B. aleutica*), and Bering skate (*B. interrupta*). Catch data (1999-2012) and stomach and muscle tissue samples (2006-2007) were collected during National Marine Fisheries Service and Alaska Department of Fish and Game trawl surveys, and used as the basis for spatial and trophic analyses. Although depth ranges of all skate species overlapped, there was spatial segregation among species, with single species clustered at scales of ~20-40 kms. When multi species aggregations did occur (e.g., Aleutian and Bering skates in Shelikof Strait), there was size segregation, which could limit interspecific resource competition. Decapod crustaceans were the main prey items in the diets of all skates. Among decapods, shrimps dominated the diets of all species but *R. binoculata*, which consumed primarily brachyuran crabs. Interannual dietary differences were noted for *B. aleutica* and *B. interrupta*. Euphausiids comprised a much greater proportion of the diet during 2007 at the expense of shrimps. The diets of *B. aleutica*, *B. interrupta* (during 2006), and *R. rhina* were similar - primarily shrimps with crabs and fishes of secondary importance. Diet compositions differed significantly for all additional interspecific comparisons. Alaskan skates are generalists, consuming locally abundant invertebrates and fishes, including several commercially important taxa (e.g. pandalid shrimps, tanner crabs, gadids, flatfishes). As common benthic predators and competitors with other groundfishes, this skate assemblage likely plays an influential role in trophic dynamics and regulation of demersal marine communities in the Gulf of Alaska. We suggest that skates are ecologically redundant and that observed spatial segregation is likely a mechanism to limit competition for food resources.

*Gulf of Alaska - Fish and Fish Habitat*

**Nutritional And Contaminant Analysis Of Skates In The Gulf Of Alaska: Shaping Future Skate Demand**

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Skates are in growing demand worldwide, specifically in European and Asian markets and there is increasing economic pressure to develop directed fisheries for them in Alaska. Big skates (*Beringraja binoculata*) and longnose skates (*Raja rhina*) are the largest and most frequently landed skates in the Gulf of Alaska (GOA), yet there have been no studies done on their nutritional value or contaminant load. Currently, only the wings are retained from GOA skates and the livers are being discarded but could be an important source of high quality fish oil. Seafood is recognized as an important source of proteins, amino acids and long chain omega-3 fatty acids. However, one of the primary concerns is the level of heavy metals, particularly mercury, present in fish tissues, which may influence the demand of certain fishery products. Therefore, understanding the protein, lipid, moisture and omega-3 content of skate products, as well as the concentrations of contaminants, could be critical information to determine to long-term demand for skate products from GOA. To address this lack of knowledge, I collected 10 big and 10 longnose skates from Kodiak and Cordova, Alaska, sampled muscle and liver tissue from each individual and analyzed nutritional content (protein, moisture and lipid content and fatty acid profiles) and heavy metal load (mercury, arsenic, selenium, cadmium, lead). Muscle samples had high moisture content (80-85%), and relatively high lipid content (1-2%). Liver samples had very high lipid content (50-65%) and could be a source of oil supplements. Mercury levels were below the World Health Organization safety limits. These data will be shared with the fishing industry and will be integrated into a bioeconomic model developed to determine the most profitable and sustainable harvest strategy for skates in GOA.

*Gulf of Alaska - Fish and Fish Habitat***Burrowing Behavior, Morphology, And Habitat Of The Pacific Sand Lance,  
*Ammodytes Personatus***

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The Pacific sand lance (*Ammodytes personatus*) is an abundant, widely distributed forage fish and a key trophic component in the Gulf of Alaska ecosystem. Unlike most forage fishes, the Pacific sand lance spends a substantial amount of time buried in the substrate. We have investigated its burrowing ability and sediment preferences, revealed morphological specializations with implications for burrowing, and applied our findings to predict suitable sand lance habitat on commercial fishing grounds off Southeast Alaska. Using small schools of sand lance (n = 20) in aquaria with a single size class of sediment, we determined that it can burrow in grain sizes ranging from mud to fine gravel. However, when presented with a choice between sediments of different sizes, it preferred coarse sand with a grain size from 0.5-1.0 mm. Very coarse sand (1.0- 2.0 mm) was preferred over very fine gravel (2.0-4.0 mm) and medium sand (0.25 – 0.50 mm) was barely tolerated. Laboratory sediment preferences were consistent with those estimated from field sampling involving mixed sediment types (i.e., those dominated by coarse sands contained the greatest density of sand lance). Sediment preferences were less pronounced during night trials, when sand lance did not display a preference between coarse sand and very coarse sand. We used nanoscale accurate models of sand lance and a materials testing system, to show that it requires significantly more force to penetrate compacted than uncompacted sediments. However, the fish did not have a preference between compaction levels. We hypothesize that sand lance make their substrate choice visually rather than tactilely. Sand lance do not have the reinforced and compact skull typical of burrowing vertebrates, and we suspect this is because they have dermal adaptations to reduce friction with their preferred substrate. Results of burrowing preference experiments were used to model potential sand lance distribution among seafloor habitat types at three commercial fishing grounds off Southeast Alaska (Fairweather Ground, Cape Ommaney, Kruzof Island). This effort is a precursor to establishing effective habitat-based management for Pacific sand lance should current trends in exploitation of forage species expand into the Gulf of Alaska.

*Gulf of Alaska - Fish and Fish Habitat***Seafloor Characterization For Trawlability Using Simrad ME70 Multibeam Acoustic Data Collected Opportunistically In The Gulf Of Alaska**

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Groundfish that associate with rugged seafloor types are difficult to assess with bottom-trawl sampling gear. Simrad ME70 multibeam acoustic data and video imagery were collected to characterize trawlable and untrawlable areas and to ultimately improve efforts to determine habitat-specific groundfish biomass. We surveyed areas of the Gulf of Alaska (GOA) (20-500 m depth) aboard the NOAA ship Oscar Dyson during the summer 2011 acoustic trawl survey, from the Islands of Four Mountains in the Aleutian Islands to eastern Kodiak Island. Additional multibeam data were collected opportunistically during the winter 2012 acoustic trawl surveys. Multibeam data were collected continuously along the ship trackline (1-20 nmi spacing) and at fine-scale survey locations in 2011 (n = 21). Video data were collected at fine-scale survey sites using a drop camera (n = 47 stations). Multibeam data were matched to the spatial location of previously conducted AFSC groundfish bottom-trawl survey hauls (n = 582) and 2011 camera stations to discriminate between trawlable and untrawlable seafloor types in the region of overlap between the haul or camera path and the multibeam data. Angle-dependent backscatter strength, backscatter mosaics, and benthic terrain metrics were extracted from the multibeam data at these locations. Haul locations show separation in backscatter strength based on performance, previously classified as successful or unsuccessful due to gear damage from contact with the seafloor. Successful haul locations have values that correspond to finer grain size, or the lack of untrawlable features such as boulders and rock. A similar pattern was observed for the camera stations characterized as trawlable or untrawlable from video. Logistic regression using general linear models identified the best combination of multibeam-derived metrics to discriminate between trawlable and untrawlable seafloor types. Seafloor backscatter strength collected at oblique incidence angles, broad-scale bathymetric position index, and seafloor roughness described 55% of the variation between trawlable and untrawlable seafloor types. Maps of the predicted seafloor trawlability of the multibeam survey footprint were generated from model results. Continued opportunistic collection of ME70 multibeam acoustic data during Oscar Dyson operations will help refine existing classifications of trawlable and untrawlable areas and improve groundfish assessment in the GOA.

*Gulf of Alaska - Fish and Fish Habitat***Spatiotemporal Variation In Benthic Community Composition On Weathervane Scallop Beds In Shelikof Strait**

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We conducted an analysis of benthic communities in areas targeted by Alaska's commercial weathervane scallop (*Patinopecten caurinus*) fishery. Here, we report our findings for scallop beds in Shelikof Strait, a region that contains high densities of weathervane scallops and, over the past few seasons, has provided the highest commercial scallop harvest in Alaska. Fish and invertebrates are incidentally caught in the commercial scallop fishery and sampled by onboard observers, who have routinely collected bycatch data from scallop fishing vessels since 1993. Some species are commercially valuable, including walleye pollock (*Theragra chalcogramma*), Pacific cod (*Gadus macrocephalus*) and northern rock sole (*Lepidopsetta polyxstra*). Using observer bycatch data collected during 1996-2012, we looked for spatial patterns in community composition on weathervane scallop beds within Shelikof Strait, as well as changes in community composition over time. Another objective was to determine whether spatiotemporal differences in benthic communities could be related to environmental variables (e.g. sediment type, depth, and bottom water temperature). Non-parametric tests, including nonmetric multidimensional scaling and analysis of similarity, were used to investigate spatial and temporal differences. Whereas in other regions in Alaska, biological communities were significantly structured at the scale of individual beds, little spatial differentiation was discerned in Shelikof Strait. Temporal differences in composition, however, were observed. Results from this study inform our understanding of the scale at which benthic community composition differs in Alaska. Our analysis of bycatch data provides a quantitative baseline of benthic communities associated with weathervane scallops against which future changes can be assessed, and contributes to our understanding of essential fish habitat for both weathervane scallops and associated species.

*Gulf of Alaska - Seabirds***Geographic Structure Of Ocean Food Webs Along 4000 Km Of Alaskan Coast: Implications For Marine Predators**John Piatt, [jpiatt@usgs.gov](mailto:jpiatt@usgs.gov)William Sydeman, [wsydeman@faralloninstitute.org](mailto:wsydeman@faralloninstitute.org)Heather Renner, [heather\\_renner@fws.gov](mailto:heather_renner@fws.gov)Scott Hatch, [shatch.isrc@gmail.com](mailto:shatch.isrc@gmail.com)**Mayumi Arimitsu**, [marimitsu@usgs.gov](mailto:marimitsu@usgs.gov)Leslie Slater, [leslie\\_slater@fws.gov](mailto:leslie_slater@fws.gov)Jeff Williams, [Jeff\\_Williams@fws.gov](mailto:Jeff_Williams@fws.gov)Sarah Thompson, [farlowia@gmail.com](mailto:farlowia@gmail.com)

Seabirds are efficient samplers of forage fish which they catch at considerable depths and distances from breeding colonies. Data on their dietary habits therefore provide a valuable complement to traditional fisheries sampling, and provide insight into the structure of Alaska marine food webs over local and regional spatial scales. In particular, puffins (including tufted and horned puffins, and rhinoceros auklet) are convenient samplers because they bring whole prey back to chicks at colonies, where samples may be collected, identified and measured with relative ease. We have compiled data on puffin chick meals collected over 28 years at 40 colonies stretching from Sitka Sound to Attu Island. A total of 16,940 chick meals were collected, containing 96,692 individual prey comprised of more than 100 taxa of invertebrates and forage fish. Food webs varied geographically. In the Northern Gulf of Alaska east of Kodiak, the food web consists largely of resident coastal and bank species such as sand lance and capelin. Moving west on the continental shelf from Kodiak to the Shumagin islands, advected juvenile walleye pollock increasingly substitute for resident forage species as the basis of puffin food webs. Moving into the eastern Aleutians juvenile pollock dominate food webs, but more oceanic prey such as squid and lanternfish become common in diets; a trend that increases moving west into the central and western Aleutians. Atka mackerel dominates in the far west. These food webs cluster into 4 or 5 geographic groups, with species composition and eco-regional boundaries that parallel those observed in the diets of Steller sea lions and large predatory fish. More than just a change in composition, these regional food webs are biologically very different (resident vs. advected prey, shelf vs. shelf-edge habitats, local vs. distant oceanographic influences, differing stock recruitment patterns, age-class composition, and nutritive value, etc.). This geographic structure of food webs has important ramifications for foraging and breeding success of local populations of widely-distributed marine predators such as seabirds and marine mammals.

*Gulf of Alaska - Seabirds*

**Linking Seabird Parental Foraging And Offspring Condition To Environmental Variability In The Gulf Of Alaska.**

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Environmental variability has a bottom-up effect on seabirds. In contrast to many other breeding seabirds in the North Pacific, rhinoceros auklet (*Cerorhinca monocerata*) populations have been relatively stable across a broad spectrum of environmental conditions. To better understand the behavioral and physiological mechanisms that allow this seabird to adapt to changing environments we examined foraging behavior of breeding adults and the level of nutritional stress experienced by nestlings. To characterize inter-annual and seasonal changes in foraging behavior we deployed bird-borne temperature depth recorders on breeding adults throughout the chick-rearing period. We sampled chick diets throughout the season, and collected feathers from fledglings as they were leaving the colony. We analyzed these feathers for the concentration of the stress hormone corticosterone to determine if and when chicks were exposed to nutritional stress. We collected these data in 2012, a cool, wet summer, and 2013, a warm, dry summer. Here we discuss the results of our analysis of the foraging strategies employed by adults, chick diet composition and stress incurred between these two contrasting breeding seasons.

*Gulf of Alaska - Mammals***Cook Inlet Beluga Whale Diet Using  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values of Bone and Teeth****Mark Nelson**, mark.nelson@alaska.gov

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Understanding changes in the diet of the endangered population of Cook Inlet, Alaska, beluga whales (*Delphinapterus leucas*) through time may be important to determine whether a change in prey availability was a factor in their population decline or is currently a factor in their recovery. We used  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values to test for changes in diet during a 47 year period. Stable isotope analysis of bone from skulls revealed a depletion of  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values between 1964 and 2007. To further evaluate this trend, we sampled annual growth layers from teeth. The average value per year also showed a decline between 1961 and 2007;  $\delta^{13}\text{C}$  (adjusted for the oceanic Suess effect) declined from -13.4‰ to -16.2‰ and  $\delta^{15}\text{N}$  declined from 17.2‰ to 15.4‰. While the decline in  $\delta^{13}\text{C}$  appears steady over time, the decline in  $\delta^{15}\text{N}$  is steep from 1970 to 1978 and more gradual after 1978. The decline in  $\delta^{13}\text{C}$  is consistent with the reduction of beluga range into the upper more freshwater reaches of Cook Inlet where their prey may have a greater freshwater influence and thus more depleted in  $\delta^{13}\text{C}$  than the same prey from marine waters. The overall decline in  $\delta^{15}\text{N}$  indicates a decline in trophic level. Possible examples include a switch from pollock or Pacific herring (~15‰) to capelin or sandlance (~12‰), or a switch from older piscivorous pollock to younger planktivorous pollock. Commercial fishing records and data from fish studies will be reviewed relative to these time periods when beluga diet changed to determine which prey species may have been involved. Stable isotope analysis indicates that endangered Cook Inlet beluga whales have changed their diet over time, but further research is necessary to determine what those changes were and whether they are a factor in the current or future status of the population.



*Gulf of Alaska - Mammals***Viability And Resilience Of Small Populations: Genetic Studies Of Cook Inlet And Yakutat Bay Beluga Whales And Lake Iliamna Seals**

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Loss of genetic diversity, inbreeding depression, and demographic and reproductive isolation are central concerns in the recovery and viability of small populations. We present case studies on three small, geographically isolated populations or groups of marine mammal in Alaskan waters where patterns of variation in neutral (mtDNA, microsatellites) and non-neutral (MHC) markers revealed how historical and contemporary patterns of behavior, effective population size ( $N_e$ ), mutation, drift, and selection shape adaptive potential and individual fitness. (1) The Endangered Cook Inlet beluga whale population has yet to recover from dramatic declines in the 1990s ( $N=312$ ). Our studies revealed that these whales have been effectively isolated from other beluga populations on evolutionary time scales, had relatively large historical  $N_e$  and exhibit little evidence of loss of neutral diversity. Diversity at adaptive loci, however, was complex, where differing modes of selection may push increase or decrease diversity. (2) The seals of Iliamna Lake have been little studied to date. There is uncertainty over the species identity and level of exchange with neighboring marine populations, and the small population ( $N_{min}=235$ ) may soon be listed under the ESA. We confirmed that these seals are harbor seals (*P vitulina*), experience limited interchange with other seal populations, and have low mtDNA diversity and high allele-sharing coefficients, indicating an isolated population of small  $N_e$  that has persisted over evolutionary time scales. (3) The beluga whales of Yakutat Bay are a small ( $N \leq 20$ ) group of whales that have been consistently sighted in this region in living memory. They are characterized by a single mtDNA matriline, low nDNA diversity and a high proportion of close kin indicating they have likely persisted for at least multiple generations with a very small  $N_e$  and a relatively high rate of inbreeding. Our findings caution against assessments of population persistence and recovery that rely solely on understanding demographic and ecological mechanisms. Future investigations will focus on genome-wide diversity, regulation and epigenetic aspects of population survival and recovery, and require more active (biopsy) sampling. Finally, we introduce the concept of species resilience when predicting how natural populations will respond to environmental change and population declines.

*Gulf of Alaska - Mammals***Baby It's Cold Outside: The Effect Of Water Temperature On Nutritionally Stressed Northern Fur Seals And Steller Sea Lions****David Rosen**, rosen@zoology.ubc.ca

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Steller sea lions (*Eumetopias jubatus*) and northern fur seals (*Callorhinus ursinus*) must both contend with the thermal demands of the North Pacific and Bering Sea. However, the two species rely on disparate anatomical solutions (blubber vs fur) and represent extremes in thermal (body) mass. In addition to the “normal” thermal challenges they face, costs to maintain body temperature in cold ocean environments may be exaggerated under conditions of nutritional stress. This means that fundamental differences in insulation and body size likely have different energetic consequences for sea lions and fur seals that cannot obtain adequate nutrition. We examined the effect of nutritional stress on the metabolism and thermal capacity of captive Steller sea lions and northern fur seals at different life stages. We found that the metabolic rate of four adult Steller sea lions (mass 169-179 kg) resting in ambient air did not change when they were subjected to a 10% nutrition-induced mass loss. However, their metabolic rates while in 2 °C water were elevated in tandem with the depletion of their hypodermal blubber layer over the period of food restriction. In contrast, the metabolism of young northern fur seals (11.1-15.6 kg) that lost 6% of their body mass over a 65-hr fast did not increase when they were submerged in 4 °C water despite seasonal differences in their blubber layer. The results of this study suggest that Steller sea lions, despite their larger body mass, may be more susceptible than northern fur seals to the added thermal costs associated with unexpected mass loss and may, therefore, be more vulnerable to unexpected disruptions in their food supply.

*Gulf of Alaska - Humans*

**Understanding Conflict In The Context Of Sustainability In Cook Inlet Salmon Fisheries.**

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Cook Inlet and Kenai River salmon fisheries are Alaska's most prolific shared salmon resource accessible by the road system. For many decades, sport, commercial, and personal use fishers have utilized salmon returning to the Kenai River as a means of supporting recreational pursuits, fishing livelihoods, access to local fish consumption, and the cultural impact of this resource on the small coastal communities of the Kenai Peninsula. Conflict has long been an underlying theme of this maximally allocated fishery as different user groups vie for catch allocation, access to fish, and engage in political maneuvering through advocacy groups and the Alaska Board of Fisheries process. This study uses an ethnographic approach to identifying points of conflict between user groups as described by resource users, and frames those conflicts within Redpath et. al.'s sustainability framework. Kenai River fisheries, though prolific, have begun to show signs of stress through a weakening of the King salmon (*Oncorhynchus tshawytscha*) run, prompting an intensification of conflict within the region. This study aims to understand this conflict and identify how it may impact the long term economic, biological, social, and cultural sustainability of this fishery for the Kenai Peninsula region.

*Gulf of Alaska - Humans***A Tribal Initiative To Promote Collaborative Research And Restore Marine Invertebrates In Port Graham Bay, Alaska**

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The abundance of several species of culturally important marine invertebrates – including clams, cockles, chitons and crabs – has substantially declined in the late 1900s in Port Graham Bay. Although not fully understood, the initial decline was believed to be related to anthropogenic, natural predation, and ecosystem changes. These resources have not recovered in spite of the lack of human harvest. In 2003, the Port Graham Tribal Council and Chugach Regional Resources Commission sponsored a Wisdomkeeper Workshop with Western Scientists to share scientific and local and traditional knowledge to better understand the decline and to identify collaborative research and management projects toward restoring these resources. The Workshop resulted in a research strategy, including the identification of multiple projects, potential collaborators and funding sources. In 2011 the Port Graham Tribe initiated a collaborative effort with scientists to evaluate the accomplishments since the 2003 Workshop, identify gaps and research needs, and develop a strategy to both improve cross-cultural communications and establish long-term research partnerships to address tribal natural resource issues. The project developed and tested a systematic approach to promote two-way learning and develop long-term collaborative Tribal-Western research partnerships. A collaborative Tribal-Scientist assessment of related research efforts since the Wisdomkeeper Workshop revealed that significant progress was made in unraveling the cause of the declines, addressing contamination concerns, and documenting traditional knowledge and management practices. Many of the research topics related to resource assessments, marine science, and oceanography were not addressed. Subsequent surveys and discussions revealed many factors that contributed to the low rate of response, including a lack of coordinated follow-up, more pressing work priorities, lack of funding, inability to hire new staff, and breakdowns in communication. A Research Advisory Committee was established to work with the Tribe to evaluate information gaps and research priorities, and develop a prioritized research strategy to restore marine invertebrates. Over a dozen collaborative projects were identified to be pursued over the new few years. This systematic process was an effective approach in continuing to build relationships, understanding, mutual respect, and overall commitments towards a common goal. More information on this project can be found at [http://www.ankn.uaf.edu/curriculum/Masters\\_Projects/GlennSeaman/](http://www.ankn.uaf.edu/curriculum/Masters_Projects/GlennSeaman/).

*Gulf of Alaska - Ecosystem Perspectives*

**Volunteers Complete 24th Year Of Rocky Intertidal Photo Time Series In Western Prince William Sound**

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During 1990 NOAA began annual quantitative intertidal monitoring to document recovery of shoreline marine life at two dozen shoreline sites following the Exxon Valdez Oil Spill and cleanup. Monitoring included landscape-scale photographs of conspicuous scenes. In 2001, following termination of the quantitative work, the senior author and Dr. John Whitney returned annually to photograph a subset of eight sites plus a new shoreline created by a landslide. During the late 2000's volunteers working or living in the Sound offered to visit some of the sites. During the summer of 2013 one or more volunteers visited all sites with coordination by the senior author in Seattle. Volunteers were guided by, and beta-tested, a draft photo-site job aid prepared by the senior author. Volunteers, including people who had never been to the sites, found the guide easy to use. The resulting body of historical and current photographs represents a nearly quarter century of changes in the abundance of conspicuous biota including seaweeds, mussels and barnacles. Preliminary graphs of percent cover reveal (1) three to four 4 to 7 year episodes of alternating heavy and light cover for both seaweeds and mussels, (2) progressive multi-year buildup of algal cover at oiled and cleaned sites, (3) lack of recovery of a previously oiled mussel reef and (4) rapid colonization of bare shoreline rock created by the March 2000 landslide. This range and duration of biological variability should be taken into account when evaluating injury and recovery following the next major disturbance, be it another oil spill, tectonic event or change in climate. This is the final year of NOAA's lead in this activity. We hope future long-term monitoring programs in the Gulf of Alaska will continue to support brief annual minus-tide visits to these sites by scientists and citizens otherwise occupied with other resource monitoring activities. The entire series of site photos and documentation is being prepared for transfer to an accessible location in Alaska.

*Gulf of Alaska - Ecosystem Perspectives*

**25 Years After The Exxon Valdez Oil Spill: Recovery Timelines Of Harlequin Duck And Sea Otter Populations**

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Two species of nearshore vertebrates, harlequin ducks and sea otters, exhibited long-term lack of recovery from the 1989 Exxon Valdez oil spill (EVOS), likely due to vulnerabilities stemming from their life histories, habitat use, trophic ecology, and physiology. Long-term data on these species from western Prince William Sound provide an unprecedented description of the process of population injury and recovery, which in turn can be used to indicate the timeline over which the nearshore system recovered. For harlequin ducks, population models compiling survival, dispersal, and fecundity information estimated that return to pre-EVOS numbers in oiled areas would require 24 years, i.e., numerical recovery would occur in 2012. Also, through 2011, harlequin ducks in areas oiled during the EVOS had shown elevated induction of a biomarker indicative of hydrocarbon exposure, cytochrome P4501A (CYP1A). In 2013, CYP1A in oiled and unoiled areas was similar, suggesting that exposure to lingering EVOS oil had ceased. For sea otters, estimates of abundance in the heavily oiled northern Knight Island archipelago in 2011, 2012, and 2013 have approached estimates of pre-EVOS abundance in that area. Concordant with increased abundance, data derived from sea otter carcasses collected on beaches over decades indicate that age-at-death distributions and mortality are now similar to those from before the spill and differ from patterns of elevated mortality of prime-age animals observed post-EVOS. Further, recent trophic and morphometric studies indicate that sea otter populations are now approaching carrying capacity in that area, i.e., numbers may be limited by naturally-occurring prey abundance, not by effects of the EVOS. This body of work demonstrates the value of long-term data for documenting and understanding change in nearshore systems, including that required for defining timelines of effects of anthropogenic events.

*Gulf of Alaska - Ecosystem Perspectives*

**Sea Otters And Shellfisheries In Southern Southeast Alaska**

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The recolonization of sea otters in Southeast Alaska has resulted in direct competition with shellfisheries, which flourished for 100+ years when sea otters were absent from this ecosystem. As a result, Southeast Alaska sea otters have recently been at the forefront of Alaskan and federal proposed legislative changes. Due to this conflict between commercial and subsistence users with sea otters, we have undertaken a large cooperative research project with the following four goals. 1) Analyze sea otter survey data since reintroduction of the species in 1968 to assess population expansion. 2) Quantify sea otter diets on varying temporal and spatial scales as a function of sea otter occupation and density by observing foraging (n=699 bouts, 6,117 foraging dives). 3) Estimate the dispersal of otters on the leading edge of the population in southern Southeast Alaska using VHF telemetry on 14 female and 16 male otters tagged in May 2011 and tracked through to present. 4) Identify the impacts of sea otters on commercial fisheries in southern Southeast Alaska using historic commercial fisheries and survey data. As we approach the end of the data collection phase of the project four observations are of note. 1) The sea otter population is increasing at an exponential rate and expanding in distribution in southern Southeast Alaska. Areas of long sea otter occupation, which once experienced high density ( $>10$  otters  $\text{km}^{-2}$ ) of sea otters, appear to have stabilized with much lower densities ( $\sim 2$  otter  $\text{km}^{-2}$ ). 2) On a population scale 46% of the sea otter diet consists of commercially important species, with greater percentages of commercially important species being consumed near the edge of the range. 3) Tagged otters have traveled outside of northern extent of the range but persist as residents within the range. 4) Sea otters can decimate commercial fisheries, and declines of sea cucumbers reaching 100% can be attributed to sea otters in areas long occupied by sea otters. Commercial shellfish districts continue to be limited by a growing sea otter population with additional California sea cucumber and geoduck clam districts not opening in 2013 due to presumed sea otter predation.

*Gulf of Alaska - Ecosystem Perspectives***Ecological Interactions Between Forage Fish, Rorquals, And Fisheries In A Northeast Pacific Ecosystem**

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The aim of this study is to examine the potential effects of the recovery of depleted rorqual populations on a Northeast Pacific marine ecosystem. Some theoretical considerations suggest that such a recovery could adversely affect the biomasses of local forage fish stocks and predatory marine vertebrate populations, as well as leading to noticeable directional changes in the yields of local fisheries. This possibility has recently been discussed and investigated in the context of recovering humpback whale populations and declining Pacific herring stocks in some areas of the Gulf of Alaska, notably Lynn Canal and Prince William Sound. Similar discussions have taken place in relation to a nearly identical situation observed in the neighboring Canadian archipelago of Haida Gwaii. The pelagic ecosystems and marine mammal populations of these islands are structurally similar and closely linked to those of Southeast Alaska. This study evaluated the plausibility of the postulated ecological effects described above using ecosystem modeling techniques. The study area included Haida Gwaii and the immediately adjacent part of Southeast Alaska facing Dixon Entrance. The local pre-exploitation abundances of blue, fin, sei, and humpback whales were estimated based on the total catches of each species recorded by whaling stations, the current abundances of these species in the waters of the study area, and the intrinsic population growth rates observed for rorquals in similar ecosystems. The ecological effects of population recovery were then simulated for each of these species using a mass-balance model of the local food web constructed in Ecopath with Ecosim 6. The results of these simulations confirm that the potential recovery of some rorqual species (particularly humpback whales) could have noticeable adverse effects on the biomasses of some forage fish species (notably Pacific herring) and predatory marine vertebrates (especially pinnipeds and seabirds). However, these results also show that the effects of rorqual recovery on fisheries yields are more difficult to predict, particularly for fisheries targeting species at high trophic levels. These findings have numerous practical implications for ecosystem-based management of forage and other fish stocks and for conservation of rorqual populations in Northeast Pacific waters.



*Gulf of Alaska - Ecosystem Perspectives*

**GOAIERP: Broad-Scale Investigations Of The Gulf Of Alaska Ecosystem**

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Over 40 scientists are currently working on the large-scale interdisciplinary ecosystem study known as the Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP). The goal of this study is to use coordinated investigations at multiple levels (field work, laboratory analyses, modeling) to better understand the dynamics of the GOA ecosystem and the forces that influence the survival of juvenile fishes. The project duration is 2010-2015, with the major field activities occurring in 2011 and 2013. These activities include seasonal fish and oceanography surveys (spring, summer, fall) in the eastern and western GOA. The surveys comprise a grid of offshore stations and smaller-scale research at eleven inshore sites. With the field work only recently completed, and laboratory and modeling studies ongoing, I will provide an overview of the various research activities and present preliminary results. Highlights include retrospective analyses that describe an abrupt shift in physical and biological characteristics between the eastern and western portions of the northern Gulf of Alaska; preliminary results from individual-based models that track virtual fish larvae from spawning grounds to juvenile habitats; temporal and spatial variability in patterns of juvenile fish distribution and abundance; and the value of moored oceanographic instruments for illuminating seasonal changes in both inshore and offshore areas. Greater detail on all of these activities can be found in the associated poster session.

*Gulf of Alaska - Ecosystem Perspectives*

**Gulf Watch Alaska – Ecosystem Monitoring Highlights From The 2013 Season**

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Gulf Watch Alaska, the long-term ecosystem monitoring program of the Exxon Valdez oil spill (EVOS) Trustee Council, is completing the second year of an integrated, multi-disciplinary program to monitor the species injured by the spill and the marine conditions that affect those species. The program is in the first 5-year phase of a planned 20-year effort and includes monitoring of oceanography, benthic and pelagic species, as well as the compilation and synthesis of current and historical data from past Gulf of Alaska research and monitoring programs. Highlights from the 2013 field work in Prince William Sound, lower Cook Inlet and along the central Gulf of Alaska coast will be provided, as well as a summary of the new tools now available for public data access and initial cross-disciplinary data synthesis efforts. Among many efforts, Gulf Watch Alaska scientists are publishing results from more than two decades of killer whale research, developing new techniques to more effectively monitor forage fish populations in Prince William Sound, providing oceanographic and zooplankton time series data to inform fisheries management, investigating forcing mechanisms for sea-level variations along the Gulf of Alaska coast, and identifying site-specific variability in shellfish recruitment to near-shore ecosystems in lower Cook Inlet. The goal of the Gulf Watch Alaska program is to provide ecosystem monitoring information to help management efforts to sustain recovery of EVOS-injured species, to detect and understand ecosystem changes, and to inform the communities who depend on marine resources in the Gulf of Alaska.

## **Poster Abstracts**

*Arctic - Climate and Oceanography*

**Comparison of ShoreZone and National Assessment of Shoreline Change Data at Six Sites along Alaska's Arctic Coast**

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Alaska's Arctic coastal plain is largely composed of unconsolidated sediment cemented by ice. Warmer conditions over the past century have exacerbated coastal erosion through a variety of mechanisms along much of this coast. Variation in coastal morphology and geology has a strong influence on the style and rate of coastal erosion, and this erosion in turn impacts coastal morphology further. We compare six sites where ShoreZone imagery and ground-station data (supported by the Bureau of Ocean and Energy Management and other partners) are co-located with U.S. Geological Survey's National Assessment of Shoreline Change lidar elevation and historical shoreline change data. This comparison helps to illuminate regional differences in coastal morphology and erosion apparent in both coastal survey efforts. Our qualitative comparison may help inform efforts dependent on coastal change such as oil spill contingency planning, community and infrastructure development, and climate adaptation in subsistence activities.

*Arctic - Climate and Oceanography*

**SIPN: Sea Ice Prediction Network – A Network Of Scientists And Stakeholders  
Collaborating To Improve Sea Ice Predictions In A Changing Arctic Environment**

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The decline in extent and thickness of Arctic sea ice has significant local and global implications for ecosystems and northern communities. Improved seasonal forecasting of sea ice conditions would be useful to stakeholders planning activities in the Arctic ocean during the summer months and for understanding the impact on sea ice sensitive species. The variable nature of Arctic weather and ocean conditions and the current limits of data and modeling capabilities make seasonal forecasting particularly challenging. The Sea Ice Prediction Network (SIPN), launched over the fall of 2013, is a network of stakeholders and interdisciplinary scientists collaborating to improve and communicate sea ice prediction knowledge and tools. Project objectives include: coordinate and evaluate predictions; integrate, assess, and guide observations; synthesize predictions and observations; and disseminate predictions and engage key stakeholders. SIPN is sponsored by five U.S. agencies, including: NSF, NOAA, NASA, the Office of Naval Research-Global, and the Department of Energy. Project collaborators and interested members of the Arctic community are invited to participate in SIPN. For more information, see the SIPN website at: <http://www.arcus.org/sipn>.

*Arctic - Climate and Oceanography***SEARCH: Study Of Environmental Arctic Change—A System-Scale, Cross-Disciplinary Arctic Research Program**

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SEARCH, an interdisciplinary interagency program, works with academic and government agency scientists and stakeholders to plan, conduct, and synthesize studies of Arctic change. Over the past three years, SEARCH has developed a new vision and mission, a set of prioritized cross-disciplinary 5-year goals, an integrated set of activities, and an organizational structure. The vision of SEARCH is to provide scientific understanding of arctic environmental change to help society understand and respond to a rapidly changing Arctic. SEARCH's 5-year science goals include: 1. Improve understanding, advance prediction, and explore consequences of changing Arctic sea ice. 2. Document and understand how degradation of near-surface permafrost will affect Arctic and global systems. 3. Improve predictions of future land-ice loss and impacts on sea level. 4. Analyze societal and policy implications of Arctic environmental change. Action Teams organized around each of the 5-year goals will serve as standing groups responsible for implementing specific goal activities. Members will be drawn from academia, different agencies and stakeholders, with a range of disciplinary backgrounds and perspectives. "Arctic Futures 2050" scenarios tasks will describe plausible future states of the arctic system based on recent trajectories and projected changes. These scenarios will combine a range of data including climate model output, paleo-data, results from data synthesis and systems modeling, as well as expert scientific and traditional knowledge. Current activities include: •Arctic Observing Network (AON) – coordinating a system of atmospheric, land- and ocean-based environmental monitoring capabilities that will significantly advance our observations of arctic environmental conditions. •Arctic Sea Ice Outlook - an international effort that provides monthly summer reports synthesizing community estimates of the expected sea ice minimum. A newly-launched Sea Ice Prediction Network will create a network of scientists and stakeholders to generate, assess and communicate Arctic seasonal sea ice forecasts. •Collaboration with the Interagency Arctic Research Policy Committee (IARPC) to implement mutual science goals. SEARCH is sponsored by eight U.S. agencies, including: NSF, NOAA, NASA, Department of Defense, Department of Energy, Department of the Interior, U.S. Department of Agriculture, and the Smithsonian Institution. The U.S. Arctic Research Commission participates as an observer. For more information: <http://www.arcus.org/search>.

*Arctic - Climate and Oceanography*

**Shelfbreak Upwelling In The Presence Of Landfast Ice**

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The Alaskan Beaufort shelf is fed by Pacific water emanating from Bering Strait, and is strongly wind-forced in fall and winter due to the passage of synoptic storms. Sea ice tends to be fast on the inner shelf and more mobile farther offshore, modulating the water column response to such storms. Here we use idealized numerical simulations to understand the response of the shelf to upwelling favorable winds. The salinity, temperature and velocity respond strongly to along-shelf winds when the ice cover is mobile everywhere. In contrast, where fast ice is present there is no clear relationship between the ocean circulation. Idealized models show that the location of the fast ice edge is critical to determining the strength of the upwelling such that upwelling depth is greatest when fast ice is confined to shallow depths or absent all together. Results suggest that in a warmer climate with decreased fast ice cover, upwelling of nutrient rich water onto the shelf will increase.

*Arctic - Climate and Oceanography***Surface Circulation Patterns In The Northeastern Chukchi Sea**

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We examine a variety of northeastern Chukchi Sea circulation features as discerned from surface currents measured by shore-based, high-frequency radars (HFR). We first review current patterns under a variety of wind regimes, which show eastward flow across the central Chukchi shelf and a northeastward-flowing coastal current, except for when winds are blowing toward the southwest at speeds  $> \sim 6$  m/s. We also present how the mean shelf circulation differs for conditions in which the flow in Barrow Canyon is onto the shelf or into the basin. This overview provides the context for examining differences in circulation between the open water seasons of 2011 and 2012. In 2011, the shelf had few fronts and weak stratification due to a nearly complete absence of meltwater caused by rapid ice retreat early in the season. In 2012, the late retreat of ice resulted in copious amounts of meltwater over the shelf. This led to strongly stratified conditions and well-defined horizontal meltwater fronts. These fronts were evident in the surface currents as strong, horizontally extensive convergence zones. The HFR surface currents reflect flow throughout the water column in unstratified areas but in heavily stratified regions more likely represent flow in the upper 10 – 20 m of the water column. We examine the differences in the shelf circulation between these years in conjunction with differences in stratification, frontal structure, and regional winds.



*Arctic - Climate and Oceanography*

**Inter-Annual And Shorter-Term Variability In Physical And Biological Characteristics Across Barrow Canyon In August – September 2005-2013.**

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Physical and biological conditions across a 37 km transect of Barrow Canyon have been described for the past nine years as part of an ongoing program focusing on inter-annual variability and the formation of a bowhead whale feeding hotspot near Barrow. These repeated transects (at least two per year, separated in time by days-weeks) provide an opportunity to assess the inter-annual and shorter term (days-weeks) changes in hydrographic structure, ocean temperature, current velocity and transport, chlorophyll fluorescence, nutrients, and micro- and mesozooplankton community composition and abundance. Inter-annual variability in all properties was high and was associated with larger scale, meteorological forcing. Shorter-term variability could also be high but was strongly influenced by local wind forcing. The sustained sampling at this location provided critical measures of inter-annual variability that should permit detection of longer-term trends that are associated with ongoing climate change.

*Arctic - Climate and Oceanography***A Comparison Of Observed And Modeled Meteorological Variables Over The Chukchi And Beaufort Shelves**

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Seasonal and synoptic variations in water properties and currents are strongly influenced by meteorological forcing, as are the seasonal retreat and formation of sea ice on Arctic shelves. Direct measurements of these variables over the ocean are sparse and, during the ice-covered seasons, extremely difficult and expensive to acquire. Consequently, oceanographers rely on surface forcing fields derived from meteorological forecast models or coastal measurements that may have been collected far from the region of interest. To address these problems, Shell, ConocoPhillips, Statoil, BOEM, and the University of Alaska Fairbanks deployed meteorological buoys during the open water season on the Chukchi and Beaufort Sea shelves from 2008 to 2013. Between one and six buoys were deployed each year at various locations; most of the buoys were on the Chukchi shelf and some locations were occupied multiple years. Collected variables include air temperature, wind velocity, barometric pressure, relative humidity, and incoming shortwave solar radiation, although these variables were not always consistent between buoy deployments. In addition, there are coastal data available from the Point Lay, Wainwright, and Barrow airports and the DOE's Atmospheric Radiation Measurement (ARM) station in Barrow. We use these various observations to quantify the forecast skill of the North American Regional Reanalysis (NARR) model, which produces 3-hourly meteorological fields on a 35 km grid. We also use the observations and model to examine spatial correlation scales of the wind field as a function of frequency.

*Arctic - Climate and Oceanography***Variability Of The Circulation In The Pacific Sector Of The Arctic Ocean Derived Through The 4Dvar Data Assimilation.**

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Summer-fall circulation in the Pacific sector of the Arctic Ocean was reconstructed for periods of the 1900-2006, for cyclonic (1989-1997) and anticyclonic (1997-2006) climate states and for the period of the International Polar Year through the use of modeling with 4Dvar data assimilation. The comparison of these climatological states with the reconstructed 2008 July-October circulation reveals a significant change in the climate states. The difference is caused by drastic changes in model forcing—namely, wind forcing and sea ice conditions. Reconstructed circulation for 2008 was additionally validated with respect to available velocity observations, which were not assimilated. The distribution of the SSH anomalies reveals reasonable correlation with gridded AVISO satellite altimetry anomaly, suggesting that satellite along-track altimetry could be a valuable source of data for operational hindcast/forecast of the local circulation after its accurate re-tracking and validation.

*Arctic - Climate and Oceanography*

**Assimilation Of High-Frequency Radar Data In The East Chukchi Sea**

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The maximum-likelihood ensemble filter (MLEF) is an efficient technique of data assimilation related to both 3D-variational (3Dvar) and Ensemble Kalman Filter (EnKF) methods. We demonstrate the utility of MLEF by assimilating high-frequency radar (HFR) data into a realistic model of the east Chukchi Sea. A set of three radar stations in Wainwright, Point Lay, and Barrow provide two-dimensional resolution of the sea-surface velocity during the ice-free months of 2010. We use MLEF to incorporate this HFR data into a numerical model constructed using the Regional Ocean Modelling System (ROMS). The resulting analysis can be used as a benchmark for future operational forecasting, allowing for better real-time monitoring and decision-making as this biologically-rich region is influenced by industry and commerce.

*Arctic - Climate and Oceanography*

**A Digital Sea Ice Atlas For Alaska**

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A digital sea ice atlas has been constructed for Alaskan waters, including the Bering, Chukchi and Beaufort Seas. The gridded fields depict sea ice concentration at resolution of  $\frac{1}{4}$  degree latitude by  $\frac{1}{2}$  degree longitude over the period 1850-2012. The temporal resolution is weekly from 1953 onward and monthly prior to 1953. Primary sources include the satellite passive microwave record from 1979 onward; the Dehn, NAVOCEANO and National Ice Center historical charts for the 1950s through the 1970s; monthly charts and ship reports from Danish Meteorological Institute's annual reports from the late 1800s through 1956; and reports from whaling ship logbooks back to 1850. The digital atlas is accompanied by a user interface that provides access to the gridded data, graphical depictions of spatial coverage as well as time series, and derived metrics such as open water season length. The presentation will include an animation of the entire dataset and will include displays of sample products available through the user interface. The sea ice atlas is designed for semi-annual updates and is intended to complement other Alaskan marine data and products available through the Alaska Ocean Observing System.

*Arctic - Climate and Oceanography***Projected Future Duration Of The Sea-Ice-Free Season In The Alaskan Arctic**

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Future sea ice conditions of the Alaskan Arctic over the next few decades are explored using the latest coupled climate models. The Alaskan Arctic, including the Chukchi and the Beaufort Sea, has been a major region of summer sea ice retreat since 2007. For the region north of the Bering Strait (70° N), future open-water duration may extend from a current 3-4 months to five months by 2050 based on the mean of 12 climate models. From December through June most of the Alaskan Arctic will remain sea ice covered into the second half of the century; these seem to be solid climatological limits based on seasonality of radiation and sea ice cover. Open-water duration in the Alaskan Arctic expands quickly in these models over the next decades, in contrast to model under-predictions of sea ice loss for the entire Arctic. Uncertainty is generally plus/minus one month estimated from the range of model results. Continued increases in open-water duration over the next two decades will impact regional economic access and potentially alter ecosystems.

*Arctic - Climate and Oceanography*

**Mapping The Northeastern Chukchi Sea Surface Currents And Their Dynamical Response Under Different Environmental Conditions**

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Three high-frequency (HF) radars deployed along the northwest Alaskan coast during the ice-free season in 2010 made near real-time surface current measurements. Although the data coverage is unprecedented, several persistent data gaps exist due to intermittent ionospheric interference, periods of insufficient scattering waves on the ocean surface, and limitations of the HF radar's siting. To fill the data gaps, reduce noise, and reconstruct the major sea surface current patterns, we apply optimal interpolation (OI) to form a more complete estimate of the current vector. This study includes a detailed investigation of the OI method's benefits and limitations. Main uncertainties originate from the degree of distortion of the antenna pattern. Twelve current patterns were extracted using a self-organizing map approach. The major patterns are two oppositely oriented coherent coastal jets associated with local southerly and northerly winds. A double vortex system is found when the wind is transitioning. The results suggest that the remaining patterns are related to far-field forcings such as coastal-trapped or continental shelf waves, and/or wind transitions associated with variations in the position of the Aleutian Low.

*Arctic - Climate and Oceanography*

**A Statistical Summary Of Current Velocities In Barrow Canyon And On The Western Beaufort Shelf**

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Current velocity statistics are presented for year-round and short-term deployments of acoustic Doppler current profilers moored in Barrow Canyon and on the adjacent Beaufort shelf during 2007-2013. Maximum velocities of ~180 cm/s were recorded in Barrow Canyon and ~100 cm/s near the coast on the Beaufort shelf. The principal axes of current variance are generally aligned with isobaths; currents being the more strongly rectified at shallower locations. Current velocity variations at all mooring locations are shown to be generally well-correlated with changes in the local wind regime.



*Arctic - Climate and Oceanography***The Distributed Biological Observatory (DBO): Research Coordination By The U.S. Interagency Arctic Research Policy Committee (IARPC) Implementation Team**

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In response to dramatic seasonal sea ice loss, the Distributed Biological Observatory (DBO) was envisioned in 2009 as a change detection array to measure biological response to physical variability along a latitudinal gradient extending from the northern Bering Sea to the Beaufort Sea. By design, DBO sampling is focused on five regions of high productivity, biodiversity and rates of biological change. Subsequently, representatives from multiple US agencies, academic institutions and industry, along with the international Pacific Arctic Group (PAG), endorsed the DBO concept, and a pilot study focused on sampling two of the five DBO regions was launched in 2010. By 2012, the Interagency Arctic Research Policy Committee (IARPC) in the USA, comprised of representatives from 13 Federal agencies, developed a five year plan (2013-2017) focused on seven research themes, with further development of the DBO included under the first theme: Sea ice and Marine Ecosystems. Since 2012, a US DBO Implementation Team (IT) has met via monthly teleconference, with the overarching goal of implementing sampling in all five DBO regions by 2015. Currently, the DBO IT consists of 37 participants, 25 from seven Federal agencies and 12 non-Federal partners. The work of the DBO IT is framed by 11 milestones, 4 of which have been completed and 7 that are in progress. Activities and products developed via collaborations facilitated by the DBO IT include: (i) annual DBO sampling from various national and international platforms (NSF/UMCES\*); (ii) development of satellite visualizations products (NASA); (iii) a portal for physical oceanographic data (NSF/WHOI\*); (iv) a password protected DBO Data Workspace (AOOS\*); and (v) coordination of national and international contributions to the DBO, via the Pacific Arctic Group (NOAA). The DBO IT is now focused on integrating data from 2010-2013 sampling, to demonstrate the value-added by this multiple sampling shared-data approach to investigation of biological responses to a rapidly changing Arctic marine ecosystem. Expanding from the Pacific Arctic sector, the DBO will also serve as a framework for international research coordination via the Arctic Council Circumpolar Biodiversity Monitoring Program (CBMP), and is a recognized task of the pan-Arctic Sustaining Arctic Observing Network (SAON).

*Arctic - Ecosystem Perspectives*

**The Pacific Marine Arctic Regional Synthesis (Pacmars) Data Archive**

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The Pacific Marine Arctic Regional Synthesis (PacMARS) is contributing to a greater understanding of the marine ecosystem in the greater Bering Strait region, including the northern Bering, Chukchi and Beaufort Seas. This synthesis effort will contribute to an understanding of North Pacific ecosystems in order to enable effective management and sustainable use of marine resources, from subsistence use to fisheries to industrial exploration and development. To manage the data for this synthesis effort, the NCAR Earth Observing Laboratory (EOL) has brought together data and metadata from an international selection of existing data sets into a dedicated, project-specific archive. The PacMARS Data Archive (<http://pacmars.eol.ucar.edu>) was developed to facilitate the visualization and integration of the archived marine ecosystem data and products by presenting the various datasets in a common format as Geographical Information System (GIS) layers upon a map of the study region. Various data types such as chlorophyll, primary production, hydrography, currents, and winds are being mapped into multiple GIS layers. Selecting overlays to view in the GIS display groups datasets and shows interrelationships, while also displaying base layer information, such as bathymetry, multibeam data, geography and gridded latitude-longitude map coordinates. Each site on the map can be expanded to display the data recorded at a specific observation site (e.g. ship station, mooring) point, other ancillary information, as well as a link to access the complete dataset. The EOL data inventory/archive for PacMARS allows analysis of recent and historical data for the Chukchi/Beaufort region to permit improved understanding of processes contributing to the changes ongoing in the region. Lessons learned from this integration effort, and challenges of dealing with various formats and units, and the systematic processing required to prepare a unified synthesis dataset are highlighted.

*Arctic - Ecosystem Perspectives***An Updated Trophic Model Of The Eastern Chukchi Sea**

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Evidence of climate impacts on Arctic marine ecosystems is accumulating and Arctic marine ecosystems face additional pressures from increased human activities due to improved access following reductions in sea ice cover, such as petroleum extraction, increased shipping, and commercial fisheries. Increasing anthropogenic activity in the Chukchi Sea in combination with climate impacts can affect food web dynamics, emphasizing the need for a baseline understanding of trophic dynamics in this ecosystem. A preliminary mass-balance food web model of the eastern Chukchi Sea has previously been developed by scientists at the NOAA Alaska Fisheries Science Center, using historical data from published and unpublished sources, focused on the base time period of 1990. We have updated this existing food web model to better represent current conditions in the Chukchi Sea food web, with data collected during the BOEM funded Arctic EIS 2012 summer bottom trawl and surface trawl surveys of the eastern Chukchi Sea, and with more recent data available in the literature. We updated biomass density estimates, diets, and rates for production and consumption for several marine mammal, seabird, fish, and invertebrate functional groups. This poster presents key changes from the preliminary model to the current model, and presents results from model balancing, including all parameters estimated by the model. A key change to the updated model is the incorporation of region- and species specific diet data for fishes of the eastern Chukchi Sea. The updated model also features a new functional group for Alaska skates (*Bathyraja parmifera*). Similar to the original model, balancing of the updated model indicated that density estimates of most fish groups derived from trawl survey data using area swept methods were insufficient to match the consumptive demands of predators, and that densities needed to be several-fold greater to meet modeled demand.

*Arctic - Ecosystem Perspectives***A Spatial Assessment Of Organic Contaminants And Hydrocarbons In Chukchi Sea Sediments: Results Of The COMIDA And Hanna Shoal Ecosystem Study Projects**

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Increased interest in offshore oil and gas exploration in Alaska has prompted the Bureau of Ocean Energy Management to support research programs aimed at robust baseline assessments of potential drilling sites on the Chukchi shelf. The Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA) project characterized the sediment chemical composition and biota of the Chukchi Sea Lease Sale 193 area and included a comprehensive study of carbon sources, trophic cycling and biogeochemical processing on the Chukchi shelf. In 2012, the Hanna Shoal Ecosystem Study extended the goals of COMIDA to another critical area with the potential to be affected by future drilling activities. The Hanna Shoal region is recognized as a biological “hotspot” with high primary productivity and large standing stocks of benthic biota. Circulation patterns influence the biological and chemical properties around Hanna Shoal, and an ecosystem-based investigation was initiated. Our goals for both programs were to document the distribution and concentration of organic contaminants (n-alkanes, PAHs) in surface sediments representing 83 sites spanning both study areas and link those to important processes. Several sites were re-occupied during the 2009-2010 and 2012-2013 process cruises to allow multi-year data analysis of potential change over time. Overall, Chukchi shelf sediments show low levels (149-2956 ng g<sup>-1</sup> dry wt) of polycyclic aromatic hydrocarbon (PAH) contamination derived from petroleum, combustion and diagenetic sources in this pristine region. The distribution of aliphatic n-alkanes was more varied throughout the study area, and hydrocarbon signatures were mainly derived from terrestrial organic sources. Total n-alkane concentrations in surface sediments ranged from 2-17 ug g<sup>-1</sup> dry wt. Both PAH and n-alkane concentrations changed little among the years sampled.

*Arctic - Ecosystem Perspectives***Computer Simulation Of Very Large Floating Structures**Jia-Jang Wu, [jjangwu@mail.nkmu.edu.tw](mailto:jjangwu@mail.nkmu.edu.tw)Ai-Ju Hsieh, [tnayru@tn.edu.tw](mailto:tnayru@tn.edu.tw)

Very large floating structures (VLFS) or very large floating platforms (VLFP) can be used to create storage facilities (for natural gas and oil), wind and solar power plants, ocean-ranches, floating airports, breakwaters, bridges, piers and docks. These VLFS (or VLFP), tend to occur near the coastlines or in the offshore seas, affect the fishing industry and marine ecology significantly. The purpose of this research is to simulate the VLFS (or VLFP) by using the modern computer technology, so that impacts of VLFS (or VLFP) to the fishing industry and marine ecology can be greatly reduced. First of all, the entire VLFS (or VLFP) system will be regarded as a structure resting on an elastic foundation and moored by vertical partial catenary cables. In which, the restoring forces due to vertical cables at two sides and two ends of the floating structure, and the buoyant forces due to the surrounding water will be modeled by the elastic forces due to the uniformly distributed equivalent springs. Besides, the righting moments and vertical potential energy due to pitching and heaving motions of the floating structure will be also considered in this research. In theory, the effects of mooring cables and liquid buoyancy can also be taken into account based on the law of conservation of energy. Next, the overall stiffness matrix and overall mass matrix of the floating structure (or wet structure) can be determined with the assembly technique of finite element method and dynamic characteristics of the entire mooring floating structural system can be calculated with the Jacobi method. Finally, the analyses of the floating structure are performed and some relevant parameters are investigated. Because the technical information concerning the current research topic is limited, the achievement of this research will provide a complete and systematic theory and technique in this aspect.

*Arctic - Ecosystem Perspectives***Will Spatio-Temporal Variation In Fatty Acid Signatures Of Prey Affect Diet Studies Of Top Predators?**

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Fatty acid (FA) composition (or “signature”) of consumer tissues can be used to identify prey species, because many dietary FAs are conserved and incorporated into predator tissues in predictable patterns. The whole-body FA signature of fishes and invertebrates could provide valuable insight into the ecology of individual prey species, as well as their trophic relationships to other organisms in Arctic ecosystems. Measuring the entire FA profile of an organism could reveal differences or similarities in the diet of species across regions and years that are not found by looking at a single FA biomarker alone. Additionally, constructing a library of prey FA signatures is crucial for diet interpretation of predator adipose tissue in upper trophic-level diet studies, such as Quantitative Fatty Acid Signature Analysis (QFASA). We are analyzing the FA signature of two species of fishes, *Boreogadus saida* (Arctic cod) and *Lycodes polaris* (polar eelpout), and two invertebrates, *Argis spp.* (crangonid shrimp) and *Macoma spp.* (clam) across multiple years (2011-2013) and geographic locations (Beaufort Sea, Chukchi Sea, and Norton Sound). Regional differences in FA composition of target species could provide insights on broad scale spatial patterns and how these could be affecting the available food sources for prey in these habitats. Moreover, if FA signatures vary among regions or years more than they vary among individuals, construction of a comprehensive library of prey species FAs will require more intense sampling effort to avoid biasing QFASA models. Quantifying the degree of within-species variability is essential to the accurate interpretation of fatty acid data used in characterizing diets of top predators.

*Arctic - Ecosystem Perspectives*

**Synthesis Of Arctic Research (SOAR) – Physics To Marine Mammals In The Pacific Arctic**

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The Synthesis of Arctic Research (SOAR) brings together a multidisciplinary group of Arctic scientists and Alaskan coastal community representatives to explore and integrate information from completed and ongoing marine research in the Pacific Arctic ([www.arctic.noaa.gov/soar](http://www.arctic.noaa.gov/soar)). The goal of SOAR is to increase scientific understanding of the relationships among oceanographic conditions (physics, chemistry, sea ice), benthic organisms, lower trophic pelagic species (forage fish and zooplankton), and higher trophic species (i.e., seabirds, walrus, whales) in the Pacific Arctic, with particular emphasis on the Chukchi Sea oil and gas lease sale areas. The first product of this synthesis will be a special issue of *Progress in Oceanography* comprised of seventeen papers addressing three overarching themes: (1) The ‘New State’ of the Pacific Arctic sector: Observations and models of sea ice loss, effects on primary production and acoustic ecology (6 papers); (2) Response of mid-level trophic species to the ‘New State’ of the Pacific Arctic: Benthic and pelagic invertebrates and forage fishes (5 papers); and (3) Response of upper-trophic species to the ‘New State’ of the Pacific Arctic: Marine mammal and seabird distribution, relative abundance, and phenology (6 papers). To date, the SOAR program has supported travel and expenses for 14 working-group meetings, providing synthesis teams the opportunity to integrate their information in-person. The special issue will be published in late 2014 and includes 80 contributors from more than 30 institutions. We anticipate that SOAR will provide a useful platform to support future collaborations among scientists, resource managers and Alaskan Arctic residents.

*Arctic - Ecosystem Perspectives***OBIS-USA - A US Marine Biological Data Resource That Spans Local, Regional, US-Interagency To International Communities**

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OBIS-USA (<http://USGS.gov/obis-usa>), a program of the United States Geological Survey Core Science, Analytics and Synthesis, is the United States regional node of the International Ocean Biogeographic Information System (<http://iobis.org>). Worldwide, OBIS nodes use the Darwin Core standard for biogeographic data, and OBIS-USA is active in the International Steering Group and activities for OBIS. In the US, OBIS-USA makes rich use of Darwin Core and extensions to serve a growing range of applications. OBIS-USA is requirements-based, meaning that priorities, innovations and relationships are driven by specific end-user needs and goals. USGS/OBIS-USA partners in the US include IOOS, US Navy, BOEM and NODC. A comprehensive requirement for OBIS-USA among all these partners is to bring practices together wherever feasible for standards of data and metadata technology, accessibility, quality management, and process coordination among institutions. OBIS-USA is a national dataset, spanning agencies, their various missions, and all US geography. However OBIS-USA responds to concerns from individual data sources, to regional coordination, to national/interagency activities, and even to global integration. To meet challenges inherent in this broad scope, OBIS-USA relies on standards, community participation, community-driven priorities, and requirements-based solutions. OBIS-USA's presentation illustrates several OBIS-USA services related to enriching and extending the uses of marine biological data, and the benefits that these services help capture, cost-effectively, for participants. Data become discoverable, more easily assessed and understood for application use, technologically accessible via web services, and above all, attributable for citation of data originators. Participation in OBIS-USA also assists archive of data with the National Oceanographic Data Center (NODC). Alaska marine regions are important national priorities. OBIS-USA has already engaged requirements to support Alaska-regional biological data needs, and OBIS-USA aims to extend its Alaska-region data community involvement.



*Arctic - Ecosystem Perspectives***A New High-Resolution Coastal Topography Data Set Along The North Coast Of Alaska**

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As part of a U.S. Geological Survey assessment of coastal change along the Arctic coast of Alaska over 11,000 km<sup>2</sup> of airborne lidar elevation data were collected between 2009 and 2012. Data coverage includes the barrier islands and mainland coast between Icy Cape and the U.S.–Canadian border, from the shoreline to ~1.5 km inland. Data coverage extends further inland to around 3 km on the Barrow Peninsula and along the coast of the Teshekpuk Lake Special Area (TLSA) where coastal erosion rates are among the highest in the world (> 18 m/yr). Data were not collected over most river deltas or large embayments, with the exception of Admiralty Bay, Smith Bay (Ikpikpik Delta), Kogru River, and the Fish Creek portion of Colville River Delta. Nominal point density of the data set is 1.5 m and the vertical accuracy is better than 30 cm. The elevation data are referenced relative to the GRS80 ellipsoid due to the inaccurate GEOID model in Alaska. Our primary use of the lidar data is to establish a modern shoreline position to be used for change analyses with historical shoreline positions. In addition, the lidar data provide a wealth of topographic and intensity information that can be used for morphological mapping of the remote Arctic coast. This is one of the first comprehensive lidar datasets collected in a continuous permafrost environment. Many periglacial landscape features, such as patterned ground, ice-wedge polygons, and thermokarst lakes and former lake basins (recent and relict) are discernible in the dataset. Typical coastal landscape features including shoreline position, beach width, slope, and bluff height and morphology are also distinct. Here we present an overview of the dataset and examine methodologies developed to characterize and classify landscape features and estimate offsets between ellipsoid and sea-level elevations. These offsets are needed to derive sea-level datum based shoreline positions and for improving coastal inundation assessments driven by sea-level datum based water-level models.

*Arctic - Ecosystem Perspectives***Patterns Of Mercury Biomagnification At Lower Trophic Levels In The Northeastern Chukchi Sea**

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Although Hg contamination is of continuing concern in the Arctic, our knowledge about the distribution of Hg in seawater, sediments and organisms from lower trophic levels is limited, especially for the Chukchi Sea. Yet, uptake of Hg at lower trophic levels provides an important link between Hg in the environment and enrichment of monomethyl Hg (MMHg) in seabirds and marine mammals. Results for Hg in seawater, sediments, plankton and benthic fauna from the northeastern Chukchi Sea (NECS) were obtained as part of the Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA) project. With this data, we can now provide new insight to the early stages of Hg biomagnification in the NECS. Concentrations of total dissolved Hg averaged  $0.56 \pm 0.28$  ng/L in the NECS with consistently lower concentrations at depths near the chlorophyll a maximum, a likely response to Hg uptake during primary productivity. Average concentrations of total Hg (THg) in biota were <10 ng/g in plankton, ~50 ng/g in bivalves, >130 ng/g in snow crab and fish and ~200 ng/g in whelk. The fraction of total Hg present as MMHg was <10% in plankton, ~30% in bivalves and >78% in snow crabs, fish and whelk. No discernible anthropogenic Hg was found in sediments except within 300 m of two historic oil drilling sites and no correlation was observed between concentrations of THg and MMHg in sediment and biota. Our results also indicate that Hg concentrations within species vary as a function of total benthic biomass. For example, the lowest concentration of THg (46 ng/g) for snow crab was found at a station with high biomass (561 g/m<sup>2</sup>) whereas the highest concentration of THg (288 ng/g) was obtained at a station where biomass was low (103 g/m<sup>2</sup>). Overall, MMHg enrichment between successive trophic levels, based on  $\delta^{15}\text{N}$  values, occurred with a biomagnification power of 0.19 where  $\log[\text{MMHg}] = 0.19[\delta^{15}\text{N}] - 0.84$ . Based on this model equation, an increase of only 1 ng/g MMHg in phytoplankton, possibly mediated by changing productivity, would be biomagnified to an increase of ~30 ng/g at trophic level 4 (snow crabs).

*Arctic - Ecosystem Perspectives***Understanding Regional Coastal Change Along The North Coast Of Alaska****Bruce Richmond**, brichmond@usgs.gov

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Rapid climate change and resulting impacts such as decreased seasonal sea-ice cover are already threatening sensitive Arctic ecosystems and unique species, oil and gas infrastructure, traditional villages and lifestyles, and historical sites along the arctic coast of Alaska. A number of related studies are being conducted to document the rates and locations of coastal change and to better understand some of the driving processes. Here, we provide an overview of studies conducted by the USGS and Shorezone collaborators. In an effort to document the rate of coastal change the USGS have compared shorelines from historical maps, imagery, and recently acquired (2009-2012) airborne lidar. With the exception of the major river deltas, the north coast is dominantly erosional, with an overall average erosion rate of -1.6 m/yr (range -18.6 m/yr to +10.9 m/yr). To assist with interpretation of change rates geo-located oblique photography and videography was collected during the summers of 2006 and 2009 and are particularly useful for discriminating coastal features such as the presence and/or absence of slumps, erosional scarps, notches, thermal niches, permafrost layers, bluff protection structures, and tundra vegetation. Recent ShoreZone imagery and mapping will significantly contribute to the coastal habitat database. USGS and ShoreZone field data include photography, GPS surveys of coastal morphology, geologic mapping with stratigraphy, sediment size and composition, ice content, nearshore bathymetry, and ground and bluff temperature gradients. For example, a study at Arey Lagoon and Barter Island has combined field data with numerical modeling to show that inundation and overwash of the barriers are primarily due to the combined effect of storm surge and wave runup, but that storm surge has a greater effect and that the storm surge is mostly driven by wind-induced setup. Primary failure modes of Barter Island bluffs are a combination of thermal degradation and thawing of permafrost, mechanical and thermal niching at the toe, rotational slumping of the higher bluffs, and block collapse of the lower bluffs at the flanks of the island.

*Arctic - Ecosystem Perspectives***A Resident Seabird's Perspective On A Changing Arctic: Using Black Guillemots To Monitor And Sample A Marine Ecosystem**

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Our knowledge of arctic marine ecosystems has benefitted from a recent increase in research effort made possible by both a lengthening annual period of open water and increased funding associated with offshore development. However, the constraints of seasonal sea ice and a paucity of sampling platforms continue to limit traditional (i.e. shipboard) biological oceanographic sampling. Regular monitoring of an upper trophic level sentinel species can provide insights into annual and seasonal variation in marine ecosystems not available through conventional techniques. The Black Guillemot, a diving seabird, has been studied annually at Cooper Island, 35 km east of Point Barrow, since 1975. Monitoring of breeding success, feeding ecology and adult survival has shown the species to be a sensitive indicator of annual and seasonal variation in the pack ice and nearshore ecosystems. Recent decreases in breeding success are correlated with major reductions in summer ice extent and increasing SST, which both reduce the availability of Arctic Cod, the guillemot's preferred prey. Digitizing of the Cooper Island database was recently completed and analysis of the four-decade-long time series is underway. Monitoring of the guillemot colony is continuing and will be supplemented by collaboration with recent research initiatives in the region. A number of agencies and institutions are now collaborating with Friends of Cooper Island as concerns about climate change and offshore development have increased. These research projects include studying: annual variation in adult guillemot survival and egg size (an indicator of prey availability) as part of an extensive examination of recent variation in guillemot demographics (UMt); seasonal and annual variation in Arctic Cod habitat, location and availability through deployment of temperature/depth data loggers on adult guillemots (IRD, UAF); nearshore fish abundance and distribution (FIU, NSB NOAA) including determining species' caloric value (NOAA) and stable isotopic signatures (FIU); guillemot movements in relation to ice cover during the nonbreeding season using guillemots outfitted with geolocators (USGS). These collaborations will provide insights into processes affecting a high trophic level predator and permit a more holistic understanding of arctic Alaska's marine ecosystems. Both will facilitate detection and interpretation of anticipated future variation and impacts.

*Arctic - Fish and Fish Habitat***Coastal Habitats Of Alaska's Arctic Coast**

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A recently completed shoreline mapping project of the coastline between the Bering Strait and Demarcation Bay provides a comprehensive picture of coastal habitats for over 10,000 km of coastline. The ShoreZone coastal habitat mapping program provides inventories of shoreline morphology, coastal substrate types, coastal stability and shoreline biota. In addition to providing mapping data, high-resolution shoreline imagery has been or is currently being loaded to the ShoreZone website so that thousands of georeferenced photos and more than a hundred video files can be web-accessed. The dataset allows resource managers instant access to co-registered imagery and mapping data. The mapping identified 4,245 km of shoreline as dominated by periglacial or thermokarst processes; thermokarst landforms included landforms such as inundated tundra (15%), ground-ice slumps (8%) and low, vegetated peat scarps (17%). Salt marsh vegetation (dominated by mixture of salt tolerant grasses, herbs and sedges) is very common (70 % of shoreline) and is considered highly sensitive to spills. The datasets provide metrics on the extents of various sensitive shorelines. For example, in the southern Chukchi Sea region, coastal sensitivity to storm surge inundation was rated as high (>50 m storm surge inundation landward of the high water line) for more than 45% of the shoreline. Much of these inundation areas are highly sensitive to storm surge due to high densities of thaw lakes (>25% coverage of thaw lakes) which are susceptible to thaw settlement and thaw-lake coalescence. Extensive areas of submerged tundra (polygonal fracture pattern visible underwater) were observed and mapped.

*Arctic - Fish and Fish Habitat*

**Preliminary US Trans-Boundary 2012 Results: Age-Length Relationships Of Fishes In The Beaufort Sea**

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Limited information exists for fish life histories in the Beaufort Sea. Understanding the impacts of climate change and oil and gas exploration to Arctic fish species are of great interest to scientists and the surrounding communities. In 2012, a team of scientists from the University of Alaska Fairbanks (UAF) and the Canadian Department of Fisheries and Oceans (DFO) collected demersal fishes in the central US Beaufort Sea as part of an ongoing, multi-year, multi-disciplinary study. The length-at-age relationships of two abundant Arctic fishes were examined to increase understanding of basic life histories. Due to the number of total fish collected, relationships were only examined for the most abundant species: Arctic Cod, *Boreogadus saida* and Arctic Staghorn Sculpin, *Gymnocanthus tricuspidis*. Otoliths were transversely sectioned and photographed under transmitted light to better estimate age. Length-at-age regressions were calculated for both species and compared to data collected in 2011. Results from this project will be integrated with data from additional years of data collection to create a comprehensive picture of age structure of important species in the Beaufort Sea.

*Arctic - Fish and Fish Habitat***Short-Term Variation In Nearshore Fish Communities In Barrow, Alaska**

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Nearshore coastal areas near Barrow, Alaska, play an important role in supporting human subsistence activities and providing foraging areas for marine mammals and seabirds. Little is known about the role these shallow ecosystems play in the growth and development of forage fish. This study characterizes short-term changes in the composition and structure of nearshore fish communities during the open water season. During summer months the coastal waters of Barrow experience rapid, wind driven changes in temperature, salinity, and ice conditions which resulted in changes in catch composition and catch per unit effort over a period of days. Fish were collected by beach seine at twelve sites around Barrow weekly between July 14th and August 25th, 2013. Catches were dominated by age-0 fish; approximately 98% of specimens caught over six weeks were larvae or age-0 juveniles, demonstrating the importance of the nearshore as nursery habitat. Catches varied both within and between sampling sites. Dominant species caught included capelin (*Mallotus villosus*), Pacific sand lance (*Ammodytes hexapterus*), and *Cottidae spp.* The abundance of juvenile capelin and sand lance fluctuated significantly over the ice-free period, while sculpins were present more consistently. Capelin abundance rose and fell over the 2 month period, while sand lance abundance continued to increase. Length frequencies varied throughout the sampling period, suggesting that growth was occurring in certain species, such as sand lance. In capelin, growth appeared to be negative, suggesting that larger individuals were abandoning the nearshore for more favorable habitat. Analysis of nutritional condition and energy allocation strategies can provide further explanation as to how juvenile fish utilize nearshore Arctic areas during the brief open water season. Care must be taken when evaluating highly variable nearshore ecosystems where infrequent sampling events may not completely describe fish communities or abundance.

*Arctic - Fish and Fish Habitat***“Arctic Snow Crab Diets: Comparison Of  $\Delta^{13}\text{C}$  And  $\Delta^{15}\text{N}$  Stable Isotope And Stomach Content Analyses”**

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This ongoing study seeks to provide improved knowledge on snow crab trophic ecology on the Chukchi and Beaufort shelves using stable isotope and stomach content analyses. Stable isotope values provided a time-integrated view of the carbon sources used and the trophic position occupied by Arctic snow crab, while stomach content analysis provided information on the exact prey items consumed. Muscle tissue was collected from snow crabs in four geographic regions (western and central Beaufort and northern and southern Chukchi) and at various depths for stable isotope analysis. Crab stomachs from the same regions were removed from fresh or frozen crabs, preserved and later dissected under a microscope. Prey items were identified to lowest possible taxon, photographed, and recorded as frequency of occurrence. Isotopic values of Chukchi and Beaufort Sea snow crabs ranged from -21.2 to -15.8‰ ( $\delta^{13}\text{C}$ ) and 12.4 to 17.3‰ ( $\delta^{15}\text{N}$ ) with Beaufort crabs occupying a more narrow range in  $\delta^{13}\text{C}$ . These results show snow crabs are predator/scavengers and generally occupy intermediate to high trophic levels. Prey items recovered from stomachs included bivalves, brittle stars, crustaceans (including conspecifics), fishes, and polychaete worms. Bivalves occurred more frequently in stomachs of western Beaufort and northern Chukchi crabs while polychaetes dominated crab stomach contents in the central Beaufort and southern Chukchi Seas. The present study will provide regionally explicit trophic information for *C. opilio*, which can ultimately assist in the development of better monitoring and management tools of this species should it become a fisheries resource in a future, more ice-free Arctic.



*Arctic - Fish and Fish Habitat***Arctic Marine Fish Ecology Catalog**

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A significant amount of fishery research in the Chukchi and Beaufort seas was conducted in the last decade to address NEPA requirements for offshore oil and gas development in the Arctic. In planning for new lease sales, the Bureau of Oceans and Environmental Management recognized the need for an updated synthesis of regional fishery information in light of NEPA requirements and stakeholder needs. The Arctic Marine Fish Ecology Catalog represents a major synthesis and biodiversity milestone confirming the presence of 105 marine species and describing what is known about the biology and ecology of each with respect to observations from Alaska, adjacent seas, and other locations. A species account for each marine fish summarizes what is known - and not known - about geographic distribution, abundance, life history and habitats, community relationships and population ecology, and ecological roles. Each species account represents an autonomous review of relevant data and information; each is fully referenced and key scientific literature sources were identified for quick access by users requiring additional detail. Collectively, they are the most comprehensive inventory undertaken of this fauna to date. They are comprehensive with respect to information presented, some of which reflects quantitative depictions of complex ecological concepts and population understanding. The species accounts are supported in synthesis chapters that more fully examine the origins and adaptive strategies of Arctic marine fishes with respect to geologic and climatic histories. Life history attributes of dominant species are evaluated with respect to resource management and their resiliency to disturbance events. The marine fauna is further reviewed with respect to changes in taxonomic nomenclature, Arctic endemism, regional abundance and assemblages, biotic interactions, and environmental concerns regarding fisheries and climate change. Visualization products include photographic images of adult specimens of fish and, new-to-science depictions of geographic range and vertical distributions for each species. The authors offer their perceptions of priority science and technology needs in a rapidly changing Arctic. Dedicated long-term monitoring and integrated assessments of biodiversity (field, laboratory, and museums) are proposed as part of the essential framework needed to advance descriptive and interpretive components of biogeography.

*Arctic - Fish and Fish Habitat***The Effects Of Climate Variability On Juvenile Pink And Chum Salmon Growth And Condition In The Northeastern Bering And Chukchi Seas**

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Anthropogenic effects continue to contribute to rising air temperatures in the Arctic. Consequently, warmer temperatures have led to advancement in spring ice melt and increases in open water. 2012 set a new record for low snow and summer sea ice extent in the Arctic. These changes in the Arctic and subarctic regions have coincided with recent observations of northward expansions of many marine organisms, including juvenile salmon. In September of 2007, the U.S. Bering-Aleutian Salmon International Survey (BASIS) was expanded northward to include the Chukchi Sea. The survey found warmer sea surface temperatures in the Chukchi Sea (CS) compared to the northeastern Bering (NEBS). Larger juvenile chum (*Oncorhynchus keta*) and pink salmon (*O. gorbuscha*) were also found in higher abundances in the CS relative to salmon inhabiting the NEBS. Additionally, juvenile salmon sampled in the CS fed on prey with higher energy content. However, analysis of variance (ANOVA) revealed that juvenile salmon whole-body energy content (WBEC; measured as calories per gram) between the NEBS and CS regions did not differ significantly. This project will build upon the work of the 2007 BASIS survey by integrating data collected from research cruises by the Arctic Ecosystem Integrated Surveys (Arctic Eis; 2012-2013) in order to investigate the ability of the NEBS/CS regions to support juvenile chum and pink salmon growth and body condition. Insulin-like growth factor-I (IGF-I; available 2012-2013) levels and energy content (WBEC) will assess growth and body condition. IGF-I is a growth hormone that stimulates muscle and cartilage growth and is an accurate measure of relative growth rate. Stomach fullness will be used to make comparisons on feeding success between regions. Initial analyses from 2012 reveal significantly lower sea surface temperatures in the NEBS/CS region compared to 2007. Juvenile salmon surveyed in 2012 also showed decreases in body condition and length. WBEC of both juvenile chum and pink salmon were higher in the CS compared to the NEBS. Juvenile chum salmon also had elevated IGF-I levels in the CS. Juvenile pink salmon had similar IGF-I levels between regions. These initial analyses highlight the complexity of studying these changing ecosystems.

*Arctic - Fish and Fish Habitat***Molecular Genetics Of Arctic Cod.**

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The arctic cods, *Boreogadus saida* and *Arctogadus glacialis* are a foundational ecosystem component in Arctic marine waters. There is much to be learned about the biology of these two species. The initial aim of this study was to examine pan-Arctic, and regional scale population structure of *B. saida*, but we encountered a number of *A. glacialis* specimens in our samples which provided an opportunity to initiate study on this species as well. Here we report on the development and application of molecular genetic tools for understanding the biology of these two small gadids. Cross species amplification of previously existing loci, and DNA sequencing of 9497 expressed sequences, was used to identify 19 and 16 microsatellite loci for use in *B. saida* and *A. glacialis* respectively. These markers were used to reveal at least three large scale groups across most of the range of *B. saida*; there is also indication of intra-regional population structure as well. We did not find any evidence of sympatric differentiation when testing for genetic differences between two differently sized larval cohorts. Primers that amplify the cytochrome-b gene (*cytb*) were developed and used to test for population structure, again showing evidence of large scale structure of *B. saida*. We also used DNA sequence analysis of *cytb* to discriminate between *B. saida* and *A. glacialis* this analysis enabled us to show that that the Gmo8 microsatellite DNA test for discrimination of these two species was not as reliable in western arctic waters as it is in European waters.

*Arctic - Fish and Fish Habitat*

**Planning For Oil Spill Natural Resource Damage Assessment In The Alaskan Arctic: Developing High Priority Ephemeral Data Collection Guidelines**

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The Alaskan Arctic is facing changing conditions that increase the likelihood of a marine oil spill in the region. Natural Resource Damage Assessment (NRDA) is a legal process conducted by State and Federal natural resource trustees in the event of an oil spill that impacts trust resources (habitat and biological resources). The NRDA process identifies and quantifies injuries to resources and determines the types and amounts of restoration required to restore those resources and compensate the public for interim losses. During the first phase of the NRDA process, the Trustees evaluate the extent and severity of resource injuries. This generally includes collecting time-sensitive, ephemeral data to assess exposure to oil chemicals and effects of those exposures. Collecting ephemeral data would be especially challenging in the Arctic and requires knowledge and methods that are appropriate for the environmental conditions and unique habitats, organisms and resources in the Arctic. To this end a conceptual model was developed to describe potential oil exposure pathways and effects in the Arctic. Based on this model, high priority ephemeral data needs for exposure and injury assessment were identified and ephemeral data collection guidelines were developed for NRDA in the Alaskan Arctic. Draft guidelines for sampling media (water, sediment, oil and sheen) as well as for biological resources (habitat specific, tissue sampling, fish, and invertebrates) were developed from existing guidelines used in recent spills in other regions and adapted to unique Arctic habitats, resources and conditions. A subset of these guidelines was tested in nearshore areas of Alaska's North Slope in July, 2013 and each guideline was peer reviewed by a group of subject matter experts and NRDA practitioners in order to produce final guidelines that are ready for implementation in the event of an oil spill in Arctic waters. Having reviewed and validated ephemeral data collection guidelines for priority habitats and resources significantly improves preparedness to respond to an oil spill in the Arctic and helps ensure that appropriate data, of sufficient quality and quantity to support NRDA, are collected, especially immediately during or after a spill.

*Arctic - Fish and Fish Habitat***Variation In Fish Community Structure Associated With Depth And Habitat In The Canadian Beaufort Sea Including Transboundary Waters**

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The Beaufort Regional Environmental Assessment (BREA) identified significant gaps in the scientific and local stakeholder understanding of the Beaufort Sea ecosystem, one of which was baseline knowledge of offshore fishes. The BREA program is designed to address these gaps prior to new oil and gas development in the region. In 2012 and 2013, bottom and mid-water trawling methods were used in combination with hydroacoustics to describe the fish community across the Canadian Beaufort Sea at depths ranging from 20 to 1500 m. In collaboration with the US Bureau of Ocean Energy Management and the University of Alaska Fairbanks, additional sampling was conducted across the Canada-US transboundary region. Fish occurrence, relative abundance and diversity were linked with available habitats through the collection of oceanographic parameters, substrate composition and foodweb structure. Herein, fish communities are described across depth ranges and spatially from eastern Alaskan waters to Amundsen Gulf. Results from 2012 increased the known species richness of marine fishes in Canadian Beaufort waters from 52 to 64; preliminary results from 2013 indicate additional species are present in Amundsen Gulf. Pelagic diversity appears to be relatively low throughout the area (~6 species) whereas benthic diversity is much higher (~58 species). Benthic diversity decreases with depth, being highest on the shelf (to ~200m), intermediate in slope waters (~200-500m), and lowest in deepwater. Relative abundances of benthic fishes follow a similar pattern. Pelagic abundance represents an exception with most biomass represented by Arctic Cod (*Boregadus saida*). Although found in most environments, the greatest abundance of Arctic Cod occurs between 250-400m depths on the slope drop-off of the Canadian Beaufort Shelf. Similar abundances are found in Amundsen Gulf; however, they occur primarily between 200-500m depths due to the shallower nature of this area. These depth zones are complex oceanographically and represent gradients between surface water mass layers (North Pacific/freshwater influences), intermediate layer (Atlantic influence), and deeper layer (Arctic Basin influence). Despite large biomass of Arctic Cod in pelagic habitats, the diversity and sizable biomass of fishes in benthic habitats implies this zone is integral to the overall functioning and health of the Beaufort Sea ecosystem.

*Arctic - Fish and Fish Habitat*

**Fish Distribution Across 200 Miles Of The Alaskan Beaufort Sea Shelf**

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A broad scale (145° W to 155° W) survey collected fishes across ~200 nmi of the Alaskan Beaufort Sea shelf in August–September 2011. This was the first survey of fishes to intensively sample such an extensive area; 78 stations were sampled between 13 and 223 m. At least 37 species from 11 families were identified. More fishes were caught in the western portion of the study area than in central or eastern portions, which led to a distinct east-west pattern in the density of fishes. When all taxa were combined, density was greatest from ~153 °W westward. Arctic Cod *Boreogadus saida* was the single most abundant taxon captured and accounted for slightly over half of the fish captured. Though much less dense than cod, sculpins (*Cottidae*) and snailfishes (*Liparidae*) had similar distribution with highest densities in the west. Sculpins also had slightly increased numbers from 150° to 152 °W. The environmental variables most closely correlated with fish community structure were station depth, longitude, and bottom salinity.

*Arctic - Fish and Fish Habitat*

**Background PAH And Biomarker Analyses Of Nearshore Fish And Sediments Of The Central Beaufort Sea, Alaska**

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The concentrations of polycyclic aromatic hydrocarbons (PAHs) in nearshore fish are assumed to be a function of concentrations of bioavailable forms of the chemicals in ambient water, sediments, and in food sources, but have a short residence time in the fish due to rapid metabolism. In late July 2013, we collected baseline nearshore fishes and sediments in the Central Beaufort Sea using fyke nets and sediment cores. Fishes were analyzed for PAHs and indicators of PAH exposure or effects through the measurement of biomarkers (fluorescing aromatic compounds (FACs) and Cytochrome P450 1A (CYP1A), respectively). The sediment samples were analyzed for PAH, key petroleum (hydrocarbon) biomarkers (such as steranes and triterpanes), saturated hydrocarbons (such as alkanes and isoprenoids) and total petroleum hydrocarbons. Sediment grain size and total organic carbon was also analyzed to aid with data interpretation. Among the most abundant fish caught and analyzed for naturally occurring hydrocarbons and biomarkers were Arctic cisco, Dolly Varden char, Least cisco, Broad whitefish, Arctic cod and Fourhorn sculpin. Initial results show background levels of PAHs consistent with earlier studies of sediments and biota in the Beaufort Sea. The data are consistent with the hypothesis that the PAHs found are derived from natural terrestrial sources such as those found in coastal and riverine ecosystems.

*Arctic - Fish and Fish Habitat***Ontogenetic And Environmental Influences On The Trophic Roles Of Chukchi Sea Fishes**

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With climate warming and longer open-water seasons in the Arctic, there is an increased interest in shipping, oil exploration and the expansion or development of commercial fisheries. Anticipated natural and anthropogenic changes are expected to alter the ecosystem of the Chukchi Sea, including its fish communities. As a component of the Arctic Ecosystem Integrated Survey, our project is assessing the ontogenetic, spatial and temporal variability of the trophic roles (trophic level and diet source) of key fish species in the Chukchi Sea using C and N stable isotope data in the absence of a commercial fishery. Unlike diet analysis, stable isotope analysis integrates only food items assimilated by consumers and therefore more accurately represents the transfer of energy between trophic levels. During August and September of 2012, sixteen fish species and three baseline invertebrate species were collected from surface, midwater and bottom trawls within the U.S. portion of the Chukchi Sea. Generalized additive models were used to detect possible variation in the relationship between length and either  $\delta^{13}\text{C}$  or  $\delta^{15}\text{N}$  among water masses (or other environmental variables) letting either  $\delta^{13}\text{C}$  or  $\delta^{15}\text{N}$  covary with length for each fish species. We present preliminary results on the ontogenetic and spatial variability in the trophic roles of saffron cod (*Eleginus gracilis*), Arctic cod (*Boreogadus saida*), and walleye pollock (*Theragra chalcogramma*).



*Arctic - Fish and Fish Habitat***Length-Weight-Age Relationships Of Demersal Fishes In The Beaufort Sea**

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Interest is increasing in Arctic marine fish species due to climate change and recent increased activity in oil and gas exploration in the Beaufort Sea. Though studies have been conducted on fish distribution and community analyses, this study's focus is understanding the basic life history, such as length, weight and age, of nine common species found in the offshore waters of the Beaufort Sea 2011: Arctic Cod (*Boreogadus saida*), Saffron Cod (*Eleginus gracilis*), Arctic Staghorn Sculpin (*Gymnocanthus tricuspis*), Shorthorn Sculpin (*Myoxocephalus scorpius*), Arctic Alligatorfish (*Aspidophoroides olrikii*), Canadian Eelpout (*Lycodes polaris*), Stout Eelblenny (*Anisarchus medius*), Slender Eelblenny (*Lumpenus fabricii*), and Bering Flounder (*Hippoglossoides robustus*). Length-weight relationships were analyzed using the fisheries equation  $W=aL^b$ . Otoliths were transversely sectioned, then photographed under transmitted light and aged by two readers independently first, then in collaboration. Length-at-age regressions were calculated. Lengths ranged from 20 mm to 333 mm across species. All but one species' weight-length regressions had  $r^2$  values from 0.93 to 0.98. The range of  $b$  values was 2.58 to 3.24, with eight out of nine species showing allometric growth. All species had linear length-at-age relationships. In the future, more fish will be added from current cruises to create a firmer understanding of the basic life history of these Arctic fish species.

*Arctic - Fish and Fish Habitat***Beaufort Sea Marine Fish Surveys In The U.S.-Canada Transboundary Area From 2010-2013****Lorena Edenfield**, leedenfield@alaska.edu

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The US and Canada share the Beaufort Sea continental shelf and slope ecosystem. Minimal historical data exist for habitat and ecology of the fish species that range across the US and Canada border in the Beaufort Sea. Marine fish surveys have been conducted occasionally from Barrow to the Alaska – Canada border, but multi-discipline, multi-year projects spanning the Beaufort Sea are rare. As oil and gas activity increases and climate changes, more information about the sparsely documented fish species inhabiting the area is required. Trends in fish distribution and sampling efforts from 2010-2013 are presented. In 2010, a 6-day cruise sampled fishes in Camden Bay (146°W). In 2011, University of Alaska Fairbanks and Bureau of Ocean Energy Management researchers conducted fish surveys during a 21-day cruise in the Alaskan Beaufort Sea from Point Barrow (156°W) to Camden Bay (146°W). In September 2012, UAF researchers collected fish on a 10-day research cruise in a focused portion of the 2011 sampling area, 150-151°W. In 2013, UAF and BOEM researchers sampled fish during a 21-day cruise from Camden Bay (146°W) across the Mackenzie River trough in the Canadian Beaufort Sea (137°W). Each successive year of sampling increases the depth of knowledge about species presence and distribution and helps inform decisions about future cruise goals. A research cruise is planned for 2014, which will cover parts of the Alaskan Beaufort Sea and the transboundary area of the Canadian Beaufort Sea, and will provide information about abundance, distribution, habitat, and interannual variability of fish in the open water season.

*Arctic - Humans***Arctic Sea Ice Investigated By The Next Generation Of Polar Scientists**

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Sea ice is of widespread relevance for weather and climate, biology, and stakeholders in the Arctic. Numerous techniques are required to measure and assess critical aspects of sea ice through in-situ measurements and remote sensing. The consequential need to train the next generation of sea ice scientists in field sampling techniques resulted in the development of an advanced sea ice field course detailing interdisciplinary field sampling techniques in the Arctic. In May 2013, professors from the University of Alaska Fairbanks (UAF) led the third course of its kind: Field Techniques in Interdisciplinary Sea Ice Research at UIC-NARL in Barrow, Alaska. A total of 21 graduate student and post-doc participants comprising 7 nationalities supported by an advisor network of experts from the U.S., Europe and New Zealand contributed diversity and experience to the course. Working in small groups enabled the students to utilize the diverse disciplinary and cultural backgrounds to develop and synthesize functional reports. The course organization, with 9 separate modules, allowed a structural breakdown of techniques and disciplines, though none are mutually exclusive. Examples of such modules include: (1) combination of a laser leveling system, electromagnetic induction device, and synthetic aperture radar to study sea ice morphology, (2) combination of ice resistivity and ice coring to investigate sea ice dielectric properties, (3) utilizing Inupiaq traditional knowledge as an invaluable asset in sea ice research, (4) spatial variability of sea ice primary production and meiofaunal community assemblage. The results from the course document the nature of the near-shore sea ice environment in Barrow, Alaska. Participants compiled resistivity profiles yielding three structurally different layers consistent with stratigraphy measurements. Ice morphology and thickness distributions indicated relatively smooth ice with few signs of grounding close to shore, consistent with Inupiaq ice experts' observations of unusually low stability ice. Ice thickness and snow cover were found to play a key role in the penetration of photosynthetically active radiation (PAR) to support primary production and associated meiofaunal grazers across diverse sampling locations. The students gained experience in field techniques, limitations and calibration of instruments contributing significant value to future fieldwork, data interpretation and analysis.

*Arctic - Humans*

**What Did You Do On Your Summer Vacation? Wildlife Interns With The NSB-DWM**

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For the past three summers, the North Slope Borough Department of Wildlife Management (NSB-DWM) has provided internship opportunities and mentoring for NSB college students interested in working with the DWM in the future. The program has grown from one college student working with us in the summer in 2011 to six interns this past summer of 2013. Our wildlife interns attend a variety of institutions, including California Polytechnic State University in California, Dartmouth College in New Hampshire, Eckerd College in Florida, Fort Lewis College in Colorado, Highline Community College in Washington, Ilisagvik College in Barrow, University of Alaska Anchorage, and University of Alaska Fairbanks. Summer activities that the interns were involved include: stranded marine mammal surveys, subsistence harvest sampling of bowhead whale, seal and walrus, bowhead whale data entry, fish survey studies, subsistence fishing surveys, polar bear hair snare project, lemming studies, caribou and fox aerial surveys, plant sorting for vegetation studies, making bird study skins, and assisting with various necropsies that are conducted by our department in response to hunter concerns. The interns also participated in outreach activities with young students during summer camps and community events, like department tours, tundra walks, wildflower walks, and beach walks. The goal of the program is to provide interns an experience rich in field work, subsistence harvest documentation and the daily workings of the DWM. We hope this program will encourage these students to become our next generation of NSB scientists and subsistence-resource specialists.

*Arctic - Humans*

### **Local And Traditional Knowledge Validation Process: Similarities And Differences To Western Science**

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There are a lot of projects such as oil and gas production and mining being discussed for Alaska; these projects could potentially have a negative impact on our environment and people. The federal and state permitting agencies need all the credible information available to make the right decisions resulting in minimum negative impact from these proposed projects. There are two main sources of information in Alaska: western science and traditional and local knowledge (LTEK) from the Alaska Native communities. “TEK [traditional ecological knowledge] is the system of experiential knowledge gained by continual observation and transmitted among members of a community.” (Huntington 1999). Traditional and local knowledge hasn’t always been taken into consideration when permitting development because of several reasons, one of which is that the validation process is not fully understood by many people and is different from accepted western science methods (e.g. scientific method). This research project focused on understanding the validation methods used by the Alaska Natives in their learning processes. Eight experienced hunters (30+ years) from Kotzebue, Alaska were interviewed using the semi-directed interview method; the topic of these interviews was how sound affects marine mammals, and the original research topic was funded by Statoil, a Norwegian oil company. Most of the similarities and differences of how corroboration occurs were derived from the collection of stories told as well as direct questions related to the research topic. Western science and LTEK both authenticate their information by testing their hypotheses with observations. One difference between western science and LTEK is that traditional and local knowledge holders validate their information through a lifetime of experience with potentially life threatening consequences if their information isn’t dependable. LTEK holders have a reliable validation process with some similarities to the scientific method through which they gain the knowledge to support their decisions. This research supports the inclusion of LTEK as a credible, necessary, source of information needed to make safe, sustainable decisions for Alaska’s environment and people.

*Arctic - Humans*

### **The Potential Of Remote Sensing Approaches In The Study Of Arctic Sea Ice Use**

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The potential impacts of rapidly changing Arctic sea ice conditions on people and ecosystems are receiving increasing attention by the research community. At the same time, sea ice is seeing increasing use due to growing industrial activities and the convergence of a range of other ice uses into smaller areas. Here we propose to focus on the role of sea ice as a platform, in particular the direct consequences of altered ice conditions for transportation across sea ice by Arctic residents and industry. Sea ice plays an important role as a platform from which the local population can hunt and fish as well as a transportation route. Arctic communities have reported thinner, less stable ice in recent years and increasing ice related accidents. On the North Slope of Alaska sea ice roads play an important role in construction of offshore islands and economical transport to drilling sites. By documenting sea ice use in a geophysical context we can establish critical ice properties of high concern to future ice trafficability. This study explores the potential of establishing the significance of roughness and thickness distribution, as well as small-scale deformation leading to weaker ice and break out events in relation to trafficability. Specifically we explore remote sensing as a tool to monitor changes in ice use potential across the Arctic for multiple stakeholders. Synthetic Aperture Radar (SAR) may discriminate roughness scales relevant for different means of transportation. L-band SAR will be explored as a tool to detect reduced ice thickness to determine areas prone to thin and dangerous ice. Small-scale deformation results in cracks or leads, and can induce hazardous break-out events. We find SAR interferometry (InSAR) to hold promise as a tool to detect ice deformation as well as bottomfast ice extent, which in turn can inform planning and management of transportation. The ultimate goal is to investigate long-term ice use changes and to develop methods to ensure safe and economical sea ice transportation in the future.

*Arctic - Humans***Marine Shipping Vulnerability Analyses Using Automatic Identification System Data**

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Maritime transport has increased throughout the Arctic and is predicted to continue to do so as a result of multiple factors, including continued loss of summer sea ice, global economic patterns, increased interest in Arctic resource extraction, research, tourism, and coastal village needs. The increase in maritime traffic is already apparent in Alaskan waters prompting concerns over vessel, mariner, and environmental safety, as well as potential ship strikes on large cetaceans and the food security of Alaska Natives. To effectively respond to the increasing vessel traffic supporting Alaskan and global needs requires: a) documentation of traffic patterns and trends; b) understanding of risks; and c) consideration of viable policy options for addressing risks. A primary tool for understanding vessel traffic in specific areas and operating under specific policies is the Automatic Identification System (AIS). In this presentation, we demonstrate scientific applications of AIS data elsewhere, and then describe two interdisciplinary Alaskan research projects that map AIS data into a format that can inform measures to promote environmental safety and indigenous food security – one using terrestrial AIS receiver data (provided by Marine Exchange of Alaska) to investigate traffic patterns in Bering and Anadyr Straits; and another using satellite AIS data (provided by exactEarth) to investigate vessel traffic throughout the Bering Sea. Both terrestrial and satellite-based AIS data provide an invaluable data source for objective scientific analysis of vessel traffic routes, but involve unique challenges and uncertainties, including that even for small areas and time periods, data files can involve millions of records. We describe how data is processed, individual vessels are reclassified based on different regulatory oversight, erroneous points are removed, and Spatial Lines features are output for developing raster layers in conventional GIS software applications. For Bering and Anadyr straits, we overlay AIS data with satellite and historical data for bowhead and gray whales to assess potential conflicts. For the broader Bering Sea, we use AIS data to map the northern great circle route through the Aleutian Islands to identify areas at risk due to proximity to land (reducing response window) and distance from emergency response (increasing response time).

*Arctic - Lower Trophic Levels*

**The Mycoloop: The Missing Link Of Arctic Carbon Cycling**

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As the most abundant organisms on earth, microbes control the health of marine ecosystems at every trophic level. As parasites of primary producers, aquatic micro-fungi redirect carbon by colonizing up to 90% of algae. Despite this, no contemporary oceanic carbon flow and ecosystem models account for parasitism of algae in any marine system. In Barrow, Alaska, chytridiaceous fungi were observed parasitizing diatom species within sea ice, providing first evidence for a greater role of parasites in the regulation of primary production than currently known. Several unique chytrid morphologies were observed, indicating a potential reservoir of undocumented fungal biodiversity in the Arctic. PCR, cloning, and culturing is being employed to characterize fungal isolates genetically, while zoosporic ultrastructure is being characterized by TEM. Spatial diversity and community restructuring in the presence of fungal pathogens is being explored metatgenomically over time. A metatranscriptomics analysis will supplement these data by exploring the expression of all genes in the presence and absence of fungal parasites. Experimental studies are planned to study the functional approach to chytrid parasitism focusing on changes in the algal photophysiology as indicator of algal health in the presence and absence of fungal parasites.



*Arctic - Lower Trophic Levels***Epibenthic Community Structure In The Chukchi Sea (RUSALCA 2009, 2012)**Carlos Serratos, [crserratos@alaska.edu](mailto:crserratos@alaska.edu)Katrin Iken, [kbiken@alaska.edu](mailto:kbiken@alaska.edu)Bodil Bluhm, [babluhm@alaska.edu](mailto:babluhm@alaska.edu)

The Russian-American Long-term Census of the Arctic (RUSALCA) is an international, interdisciplinary program aimed at building a time-series of biological and environmental data in Russian and US waters of the Chukchi Sea. Here, we document epibenthic community structure and identify primary environmental drivers influencing community composition in 2009 and 2012. Non-parametric multidimensional scaling was used to group stations by similarity of community composition based on a resemblance matrix. In 2009, the majority of stations grouped into two geographic regions: those in the central and southern Chukchi Sea, characterized by several species of decapod crustaceans and those on the northwestern Chukchi/eastern East Siberian Sea, identified by large contributions of the isopod *Saduria* and ophiuroids. Overall epibenthic biomass in 2009 was dominated by arthropods, in particular snow crab *Chionoectes opilio*, while echinoderms were the most abundant group, with high numbers of ophiuroids occurring especially near Wrangel Island. In 2012 (when no locations were sampled west of Wrangel Island), the majority of stations clustered into central Chukchi and central Herald Canyon regions, and highest overall epibenthic biomass was contributed by echinoderms while arthropods contributed most to abundance. Biomass partitioning suggests a consistent regional difference in the dominant taxa between the central and northern study region in both study years with ophiuroids dominant in the northwestern and crustaceans in the central and southern Chukchi Sea. The influence of environmental variables was tested for their correlation with community structure, including variables indicative of hydrographic conditions, sediment characteristics, food availability and location. With the currently available subset of variables, the combination of bottom water temperature, salinity, and latitude was most correlated with patterns of epibenthic biomass for 2009, but the correlation was not very strong. In 2012, bottom water temperature, salinity, oxygen and latitude were the highest correlated variables, but ranking depended on the cluster considered and may change with more variables to be added in once available. In conclusion, epibenthic community composition differs between the northern and southern Chukchi Sea shelf, and the underlying environmental factors that influence these assemblages appear to be complex.

*Arctic - Lower Trophic Levels***DNA Barcoding Analysis Of Marine Caridean Shrimp From Alaska**

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DNA barcoding is the application of short sequences of DNA to species identification and has become a powerful discipline since its inception, aiming to assess and document biodiversity at a quicker pace than traditional methods. One of the main advantages of this method is its ability to flag species that are potentially new to science (cryptic species). It also has advantages over morphological approaches when analyzing stomach contents and identifying larval forms and damaged specimens. Accurate species identification is critical for understanding their distribution and abundance and to informing ecosystem-based management. Crangonid and Spirontocaris shrimps from the Chukchi Sea, Aleutian Islands, and Gulf of Alaska were analyzed to determine whether DNA barcoding was effective at identifying species. Preliminary results suggest that barcoding was effective at identifying species. It was confirmed that two specimens in the Barcode of Life Database (BOLD) were misidentified. Misidentifications are a major problem when using reference libraries in online databases and a serious limitation to the utility of DNA barcoding. There was high sequence divergence (9% mean K2P distance) between *Crangon septemspinosa* populations in the Chukchi Sea and its type locality in the Northwest Atlantic, suggesting the possibility of a cryptic species and warranting further study to determine if there are any additional differences (i.e., morphological, ecological, etc.).

*Arctic - Lower Trophic Levels***Distribution Of Pseudocalanus Spp. In The Pacific-Arctic As Revealed By Molecular Markers**

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Pseudocalanus (Copepod, Calanoida) are one of the most dominant genera in Arctic and sub-Arctic waters, and with current warming trends they are anticipated to expand their range further north into the Arctic Basin. However, Pseudocalanus present taxonomic difficulty in morphological identification down to the species level, and thus detailed specie-specific distribution data is lacking for this genera. We sequenced the mitochondrial gene cytochrome oxidase I (mtCOI) from four sibling species of Pseudocalanus (*P. acuspes*, *P. minutus*, *P. mimus* and *P. newmani*) to determine presence, distribution, and population genetic structure within North Pacific and Western Arctic waters. Preliminary results for Chukchi Sea samples indicate distinct COI clustering among *P. acuspes*, *P. minutus*, and *P. newmani*. K2P distances revealed within species similarity to be greatest for *P. acuspes* and least for *P. newmani*. Between species similarity was greatest for *P. acuspes*/*P. minutus* and least for *P. newmani*/*P. minutus*. We also present data on Beaufort Sea and Gulf of Alaska populations of Pseudoclanus and speculate that under future warming trends faunal boundaries may shift, increasing gene flow and therefore population connectivity between Arctic and sub-Arctic populations.

*Arctic - Lower Trophic Levels*

**Temporal Variation Of Epibenthic Communities In The Chukchi Sea, Alaska**

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Epibenthic communities contain a wide range of organisms and serve an important role in marine ecosystems. Due to climate variability, and in some areas oil and gas exploration, these communities could experience drastic changes in species composition, abundance, and biomass. Natural variation also plays a role in temporal community changes; however, currently the extent of these changes is largely unknown. Epibenthic organisms not only play a role in remineralization of carbon and contribute to overall benthic production, but changes in these communities can potentially affect higher trophic levels as well. This study examines temporal variations in epibenthic communities so as to determine how these communities change through time, and which environmental parameters are potentially contributing most to these changes. A plumb staff beam trawl was used to sample epibenthic biomass, abundance, and species composition of dominant invertebrate taxa at 20 stations around the Chukchi Sea during the ice free seasons of 2009, 2010, 2012, and 2013. Communities were found to vary among years with the amount of variation inconsistent among stations. While these data provide a benchmark on inter-annual variability, more monitoring is essential to determine long term trends.

*Arctic - Lower Trophic Levels*

**Modeling Of Ice Algal And Pelagic Production And Air-Sea CO<sub>2</sub> Exchange In The Arctic Ocean**

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The primary production in the Arctic Ocean consists of sea ice algae and phytoplankton in the ocean. The bloom period of the two kinds of primary production cover different time of the year consequently. The biological pump is strong in the shelf seas but weak in the Arctic Basin. Sea ice is usually considered impermeable of gas, but the model tends to underestimate the ocean surface pCO<sub>2</sub> in the Arctic Basin as compared with in situ measurements in summer. Observations made on sea ice suggest that the brine channels in sea ice may open when the temperature warms up to melting point. A model sensitivity run revealed that a temperature-dependent sea ice permeability of gas may reduce the model bias. The parameterization of the temperature-dependent sea ice permeability of gas is investigated on the basis of various observational data, both qualitatively and quantitatively.

*Arctic - Lower Trophic Levels***Inter-Annual Variability Of The Planktonic Communities In The Northeastern Chukchi Sea: 2008-2013**

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In 2008, a multi-year, interdisciplinary study was initiated in the vicinity of proposed oil & gas exploration areas in the northeastern Chukchi Sea. This study was designed to provide baseline environmental data that can be used for permit applications and for post-development comparisons. The planktonic communities were sampled along two 30 x 30 nm grids at Klondike and Burger at high spatial resolution 3 times per ice-free season in 2008 and 2009, with a third grid of similar area (Statoil) added in 2010. In 2011, a broad scale survey over Hanna Shoal was added over which surveys were conducted at a lower spatial resolution. The broad scale survey was continued in 2012 but not in 2013. Phytoplankton (chlorophyll a), inorganic macronutrients (nitrate, silicate and phosphate) and zooplankton (150µm and 505µm mesh nets) samples were collected. Timing and intensity of seasonal cycles varied noticeably between years. The 2009 season saw an earlier retreat in seasonal ice cover over the regions than in 2008 and 2011, and warmer temperatures, while 2010 appeared intermediate between the two. The 2012 and 2013 seasons were marked by remnant ice over the regions that interfered with sampling at some of the stations. The spring bloom was partly captured in 2008, 2010, and 2011 but not in 2009 or 2012. 2012 had the greatest biomass of copepods compared to the previous years. In 2012, the occurrence of ice associated copepods such as *Jashnovia tolli*, and *Cyclopina spp.* as well as cold water preferring *Microcalanus pygmaeus* was indicative of the colder, icier environment of the sampling areas. Pacific inducted species such as *Neocalanus spp.* and *Eucalanus bungii* were present in Klondike and southern Hanna Shoal stations whereas Acartia, Centropages, Metridia, and Microsetella were more abundant in the northern stations. The arctic species *Calanus hyperboreus* had a much lower abundance this year and was only present in the northern Hanna Shoal stations adjoining the Arctic basin.

*Arctic - Lower Trophic Levels***Projected Temperature-Mediated Range Changes In Arctic And Boreal Benthic Fauna**

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One of the logical predictions for a future Arctic characterized by warmer waters and reduced sea-ice is that species distribution ranges will change in Arctic seafloor habitats. Our objective was to explore where in the Arctic bottom water temperatures might change the most and by how much, and to identify thermal thresholds of selected boreal and Arctic taxa to estimate their potential for range changes. We ran an established coupled 3-D oceanographic-ecological model to estimate bottom water temperature changes throughout the Arctic between the first and last decades of this century based on the IPCC A1B scenario. The model was also used to estimate the average (2000-2009) August bottom temperature at geo-referenced distributional records of 65 benthic taxa with either boreal or Arctic zoogeographic affinities. Species occurrence records were extracted from the Ocean Biogeographic Information System and other sources.

According to the model, large areas of Arctic coastal and shelf sea floor will experience increases in temperature of around 2-5°C by the end of the century. Greatest temperature changes are expected on inflow-shelves (5°C), but also in the northern GIN Seas, the Kara Sea, the west Greenland coast, and the Beaufort Sea (2-3.5°C). In vertical extent, increases in temperature of up to 4°C are predicted as deep as 200 m, and 1-2°C down to 500 m throughout the central Arctic. Some Arctic species had clear upper temperature thresholds (2-6°C) while others had widespread thermal ranges (-1 to >10°C). Many boreal species showed clear lower temperature thresholds around 4 °C, 6 °C, and 8-10°C. Species with the lowest thresholds are expected to be those species expanding first and farthest into the Arctic. The apparent thermal thresholds for the selected species suggest strong potential for range constrictions of Arctic and expansions of boreal fauna in the near future.

*Arctic - Lower Trophic Levels*

**Using Imaging Flow Cytometry To Examine Phytoplankton Assemblage Structure In The Bering And Chukchi Seas**

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The composition of phytoplankton assemblages in the Bering and Chukchi Seas was examined using an automated individual cell imaging approach, in five cruises in 2010, 011, and 2013. Significant differences were observed in these assemblages between years and depending on seasonality. Nanophytoplankton assemblages and picophytoplankton were also examined using standard flow cytometry, also exhibiting distinct patterns in the Chukchi. Winter phytoplankton assemblages, although considerably lower in terms of biomass, also revealed substantial spatial structure dominated by dinoflagellates and some diatom taxa. Such detailed information on nano and microplankton assemblage composition, coupled with concurrent sampling of smaller cells using standard flow cytometry, provide an unprecedented view into the spatial structure of phytoplankton communities in the Bering and Chukchi Seas. This insight helps to advance understanding of how the complex physics and chemistry of these two seas control the distribution and timing of phytoplankton production.



*Arctic - Lower Trophic Levels*

**Assessing Benthic Meiofaunal Community Structure In The Alaskan Arctic: A High-Throughput DNA Sequencing Approach**

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Rapid change is occurring in the Arctic marine environment concurrently with increased human activity in the form of petroleum resource development, yet our knowledge of the structure and function of Arctic marine communities is still rudimentary. We cannot assess the effects of either regional climate-related trends or acute disturbance impacts on these communities without baseline data on the abundance, distribution, and structure of key faunal assemblages. We are conducting surveys for benthic meiofaunal invertebrates in the Chukchi and Beaufort Seas using a high-throughput gene sequencing approach. Sediment communities are ideally suited to tracking long-term change because they tend to dampen short-term seasonal or interannual “noise” in many environmental characteristics (e.g., primary production, hydrographic features). Moreover, meiofauna are widely used as indicators of disturbance impacts because they are non-motile, reproduce rapidly, and respond quickly to change. Despite their importance to monitoring efforts, sediment meiofaunal communities are notoriously difficult to characterize because they lack obvious morphological features used to identify species, and are time-consuming to work with due to their extremely small size. Our DNA-based approach provides an alternative to the standard labor-intensive microscopy techniques, and allows for rapid assessment of meiofaunal community structure and diversity. We are comparing results of community-structure analysis derived from both morphological and DNA-based approaches.

*Arctic - Lower Trophic Levels***Size Distribution And Abundance Of The Dominant Arctic Shelf Brittle Stars:  
*Ophiura Sarsii* And *Ophiecten Sericeum***

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Brittle stars are a key component of Arctic marine shelf systems due to their high standing stock, dominance in abundance over all other epibenthic organisms, importance in carbon remineralization, and as prey for higher trophic organisms. On the Alaskan Arctic shelves, the circumboreal species *Ophiura sarsii* and *Ophiecten sericeum* are the dominant brittle stars with known densities of 264 ind. m<sup>-2</sup> and 22 ind. m<sup>-2</sup>, respectively. Currently, information is lacking on the time scales over which these ophiuroids build up those substantial standing stocks and their rate of secondary production, although the assumption is that they are long-lived and slow growing, as typical of many arctic benthic organisms. Here we present a size frequency and abundance analysis for the two species, as a part of an ongoing project that aims to describe the age, size structure and productivity of both species. Using bottom trawl gear, samples were collected during the ice free seasons from 2009 to 2013 across the Arctic Alaskan shelves. Our results show these species have segregated geographic distributions with *O. sarsii* dominating most of the Chukchi Sea and western Beaufort Sea shelves, and *O. sericeum* dominating the eastern Alaskan Beaufort Sea shelf and selected locations of the Chukchi Sea shelf. Along with difference in geographic distribution these species have a clear size difference. Disc diameter in *O. sarsii* ranged from 1.8 to 30.9 mm (n=6,000). Disc sizes in *O. sericeum* ranged from 2.1 to 16.7 mm (n=3,000). Regional differences in dominant sizes were observed for both species. This research will contribute to an integrated understanding of Arctic ecosystem functioning and create a benchmark for future changes in population parameters of two important benthic community representatives.

*Arctic - Lower Trophic Levels***Environmental And Biological Heterogeneity In The Northeastern Chukchi Sea**

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Distributions of benthic organisms are coupled with environmental parameters suitable for each organism. Additionally, some organisms are adept at modifying their surroundings to create new micro-scale environments. The sum of these interactions results in uneven distributions of physical habitat characteristics and biological communities. Often described as “oceanographically smooth”, the northeastern Chukchi Sea is better depicted as a mosaic of benthic habitats and communities painted by largescale oceanographic processes, and highlighted by smaller scale topographic features. Data and observations collected as part of the interdisciplinary Chukchi Sea Environmental Studies Program (CSESP) demonstrate the environmental and biological heterogeneity of the area. During the 2008-2012 CSESP sediment characteristics and benthic communities were sampled by van Veen grabs, bottom trawls, and video surveys. Within the study area, habitats generally graded from muddy sediments interspersed with gravel and rock in the south, to predominantly mud in the middle regions, to sand and mud habitats intermixed with coarser sediments in the north. Benthic community composition corresponded with sediment characteristics. More upright, suspension feeding organisms were present on the southern rocky areas; deposit feeders such as brittle stars and malpighian polychaetes were abundant and dominated the muddy areas; the sandy northern area supported fewer organisms and was dominated by bivalves. Video surveys emphasized the high degree of habitat, and consequently benthic community, heterogeneity in the southern portion of the study area by visually capturing the patchiness of rocky areas and their associated biota in an otherwise muddy seascape.

*Arctic - Lower Trophic Levels***Strong Community Turnover In Epibenthos Composition Along And Across The Shelf And Slope Of The Central And Eastern Beaufort Sea****Bodil Bluhm**, babluhm@alaska.edu

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As part of the Pacific Arctic region, the Beaufort Sea exhibits both along and across-shelf gradients in physical and zoogeographical conditions. The influence of Pacific waters and species pools diminishes in benthic communities from the west to the east and from the shelf towards the deep sea. One objective in our ongoing study within the US-Canadian Transboundary program is to explore how these gradients are expressed in epibenthic communities. Epibenthos was sampled at a total of 57 stations along 9 shelf-to-slope transects (20, 50, 100, 200, 350, 500, 750, 1000 m) in the Beaufort Sea from 137.8-151.1 °W and 69.6-71.5 °N in October 2012 and August 2013. Fauna was collected using a plumb-staff beam trawl. Over 300 putative taxa were identified. As typical for Arctic epibenthos, the community was mostly dominated by echinoderms and crustaceans in abundance and biomass, and by arthropods, mollusks, and echinoderms in species numbers. Multivariate analysis documented significant change of community structure with water depth as well as with longitude. Nearshore (20 m depth) stations were dominated by amphipod, decapod and cumacean crustaceans, and shelf stations (50-200 m) were characterized by different brittle star species in the central (*Ophiura sarsii*) and eastern (*Ophiocten sericeum*) Beaufort Sea. The slope (350-1000 m) was generally characterized by a third brittle star species, *Ophiopleura borealis* and the isopod *Saduria sabini*; different additional species dominated in the central (i.e., sea star *Ctenodiscus crispatus*, snails *Tachyrhynchus spp.*) compared with the eastern (i.e., sea stars *Pontaster tenuispinus* and *Bathybiaster vexillifer*) Beaufort Sea. The community turnover with depth on the slope coincided with the transition from Pacific to Atlantic-origin water masses. A comparison with findings from the 1970s suggests that the distribution of dominant epifaunal taxa has generally persisted over the past decades.

*Arctic - Lower Trophic Levels***Stable Isotope Baselines In Marine Food Webs: A Pan-Arctic Review**

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Stable isotopes, particularly those of nitrogen ( $\delta^{15}\text{N}$ ) and carbon ( $\delta^{13}\text{C}$ ), are frequently used to assign trophic levels and track carbon flow in marine food webs, including those of the Arctic. Stable isotopic analyses have the potential to simultaneously capture complex interactions, including omnivory, and to discriminate energy flows through ice-associated (sympagic), pelagic, and benthic communities. The isotopic signature of a consumer alone, however, is not sufficient to infer its trophic position or major dietary carbon source. An appropriate isotopic baseline is also needed, but can be difficult to determine because of spatiotemporal variability in the biochemical composition of primary producers and the challenge of obtaining pure samples of autotrophic material. We have compiled isotopic baseline data relevant for marine food webs in Arctic coastal and offshore marine environments including: macroalgae, microphytobenthos, sea ice algae, phytoplankton and organic matter of terrestrial origin. Based on locally measured physical (light, nutrients, and depth) and biological (taxonomic and physiological state) variables, we have determined the isotopic signatures (means, ranges) of the above carbon sources in a pan-Arctic context to enhance our interpretation of complex food web interactions.

*Arctic - Lower Trophic Levels***Tracing The Influence Of Terrestrial Matter Across Lower Trophic Level Food Webs Of The Eastern Beaufort Slope****Lauren Bell**, lebell2@alaska.edu

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The Mackenzie River annually expels more than 380 km<sup>3</sup> of freshwater out over the eastern Beaufort Sea shelf and slope, rendering this region a highly estuarine Arctic shelf system. The substantial inflow of freshwater shapes marine food web structure along the Beaufort shelf, as terrestrial matter carried by the river water is not easily assimilated by marine primary consumers, thus disrupting the efficiency of energy transfer to higher trophic levels. Yet, with distinctly stratified boundaries between Pacific and Atlantic water masses over the steep Beaufort slope, the degree to which terrestrially-derived matter penetrates to and impacts the benthic invertebrates on the slope is unclear. The long-term objective of this study is to trace the influence of Mackenzie River outflow on the trophic dynamics of eastern Beaufort slope food webs. For this, we follow the mark of terrestrial matter through the stable isotope signatures of water, particulate organic matter, surface sediments, and pelagic and benthic invertebrate tissue. As part of the U.S.-Canadian Transboundary project, samples were collected in August 2013 from 45 stations in the eastern Beaufort Sea, ranging from 20 – 1000 m bottom depth along 5 shelf-to-slope transects between 137.8 – 146.1 °W and 69.6 – 71.0 °N. Preliminary results presented here will focus on the oxygen and deuterium isotope signatures of near-surface water samples and select benthic invertebrate taxa as tracers of terrestrial matter influence. Eventually, these data will be interpreted in conjunction with changes in food web structure across the study area as defined by carbon and nitrogen isotope analyses. As inputs of terrigenous matter to the Arctic are projected to increase with climate change, the initial results of this novel approach to food web analysis will assist forecasts of how marine trophic structure of the Arctic margins may transform in the near future.

*Arctic - Lower Trophic Levels***Snow Crabs In The Northeastern Chukchi Sea Corridor**

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In 2010 – 2012, the Alaska Monitoring and Assessment Program (AKMAP) sampled 74 Chukchi Sea stations from Pt. Hope to Barrow, Alaska. The surveyed region lies within a 25- to 50-mile exclusion corridor between the nearshore (~10 meter depth) and the BOEM Lease Sale #193. The exclusion corridor is essential for spring migration of a large fraction of marine birds and mammals destined for the North Slope and Beaufort Sea. The corridor is primarily influenced by the nutrient-poor Alaska Coastal Water (ACW), which flows northeast from Bering Strait into Barrow Canyon via the Alaska Coastal Current. Northeast flowing Bering Sea Water, which lies west of ACW, merges with ACW as a hydrographic front typically between Point Franklin and Barrow Canyon. Sampling activities at most stations included CTD and water quality, plankton tows, Van veen sediment grabs, demersal beam and otter trawls, contaminants and stable carbon and nitrogen isotopes. Snow crabs, *Chionoecetes opilio*, were one of the most ubiquitous epifaunal species caught with the beam trawl. They were found throughout the study area, but occurred in significantly greater abundance in the region between Pt. Hope and Pt. Lay (Ledyard Bay stratum) than from Pt. Lay to Pt. Barrow (Peard Bay stratum). Highest snow crab abundance occurred in the outer stations off Pt. Lay (station 11; 1.49 million crabs km<sup>-2</sup>) and Cape Lisburne (station 22; 1.15 million crabs km<sup>-2</sup>). The size of crabs throughout the study area averaged 34.6 mm CW  $\pm$  0.58 SE, with no size difference between the two strata. Males averaged 34.9 mm CW  $\pm$  0.75 and females averaged 35.1 mm CW  $\pm$  0.91. Based on the small size of males, few mature specimens were presumably in the study area. Only 6% of the 543 crabs measured were ovigerous females (46.7 mm CW  $\pm$  0.80) and those were all in the Pt. Hope – Cape Lisburne area.  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values were significantly different in crabs between the Ledyard and Peard Bay strata. These data suggest temporal-spatial variability in the hydrographic front that separates Bering Sea winter water from summer water over the Chukchi Shelf.

*Arctic - Lower Trophic Levels***Caloric Content of Infaunal Communities in The Northeastern Chukchi Sea**

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The Chukchi Sea continental shelf is a highly productive region supporting biomass-rich macrobenthic communities and several higher trophic level predators such as walrus (*Odobenus rosmarus divergens*), gray whales (*Eschrichtius robustus*), and bearded seals (*Erignathus barbatus*). Understanding drivers of prey energy content is important for predicting potential trophic-level changes associated with temporal environmental variations. Investigations of variations in energy content and environmental drivers have used weight to energy conversion factors to depict spatial variations, assuming that energy content is constant throughout a large area. This study tested the hypothesis that the environmental drivers of macrofaunal abundance and biomass also drive the species energy content. This study also evaluates the assumption of constant energy content by determining caloric variations on a per gram basis across a large study area. Macrofauna from 36 stations were collected for caloric content determinations as part of the Chukchi Sea Environmental Studies Program (CSESP) in 2012. Samples were collected with a van Veen grab, and animals remaining after washing over a 1.0-mm sieve were frozen. Fauna were sorted in the laboratory, tissue removed from shells, freeze-dried, acidified (calcifying organisms), and energy values were determined by bomb calorimetry for the amphipod family *Ampeliscidae*, the bivalves *Ennucula tenuis*, and *Macoma spp.*, the peanut worm *Golfingia spp.*, and the polychaete worms *Maldanidae* and *Nephtys spp.* and all other fauna combined ("Other"). Energy values were regressed against the environmental variables percent mud, bottom water temperature, salinity, total chlorophyll, and water depth. The taxonomic group with the lowest energy content (cal/g) was *Golfingia margaritacea*, while the greatest energy content was found for the bivalve *Ennucula tenuis*. Energy content of *Macoma spp.*, *Maldanidae*, and Other fauna were significantly influenced by environmental variables; bottom water temperature was a significant predictor of energy values for *Macoma spp.*, percent mud for *Maldanidae*, and percent mud and depth for Other fauna. Thus, energy content of macrofauna were not found to be spatially constant, indicating that consideration of environmental factors is important in evaluating caloric content within a given region.



*Arctic - Lower Trophic Levels***Evaluation Of The Extraction Efficiency Of Two Solvent Systems Using Accelerated Solvent Extraction**Tanja Schollmeier, [tschollmeier@alaska.edu](mailto:tschollmeier@alaska.edu)Katrin Iken, [kbiken@alaska.edu](mailto:kbiken@alaska.edu)Alexandra Oliveira, [acoliveira@alaska.edu](mailto:acoliveira@alaska.edu)

Trophic interactions are of great importance for our understanding of ecosystem structure, especially in light of ongoing environmental changes. Lipids are increasingly used in the analysis of trophic interactions in the marine environment, but the results can be influenced by the extraction method being used and its efficiency. Among the methods available, the Accelerated Solvent Extraction (ASE) utilizes high temperatures and pressures for lipid extraction but different solvent systems may have different extraction efficiencies, depending on the sample type. Building on traditionally used ASE solvent systems developed for various fish tissues, we modified these methods in this study to determine the extraction efficiencies of dichloromethane and of 2:1 chloroform-methanol as two solvent systems on freeze dried tissue samples of Arctic snow crab (*Chionoecetes opilio*). Extraction efficiencies were compared against those for Lake Superior fish tissue (obtained from the National Institute of Standards and Technology). A phospholipid was used as an internal standard to calculate extraction efficiency added prior to the extraction process. A second internal standard (a methyl ester) was added prior to transesterification for the accurate quantification of the fatty acid peak areas after gas chromatography. This enabled a comparison of the extraction efficiency of Arctic snow crab against a known fish tissue to determine the preferable solvent system to use for an Arctic benthic invertebrate.

*Arctic - Mammals*

**Using Nonlinear Time Sampling Of Bowhead Whale Calls To Extract Acoustic Mode Shape And Array Tilt**

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Conventional passive acoustic tracking techniques require the deployment of multiple instrument packages over wide areas, an expensive and time-consuming process. In 2010 and 2012 a 15-element vertical array was deployed in conjunction with Shell's passive acoustic marine monitoring program. Vertical arrays provide a compact deployment that can range bowhead whale sounds to at least 35 km in the Beaufort Sea. Unfortunately, practical deployments of vertical arrays face several issues, including the need to compensate for vertical array inclination, and incomplete coverage of the water column that makes the use of Strum-Liouville orthogonality problematic. Here bowhead whale signals collected in the Arctic Ocean are used to demonstrate how the use of non-linear sampling in the time domain can be used to directly invert for array tilt and normal mode shapes from an array that only spans 65% of the water column. This information can then be used to estimate the depth and ranges of calling whales. [Work supported by NPRB, Shell Exploration and Production Company, and Greeneridge Sciences Inc.]

*Arctic - Mammals*

**Measurements Of Cumulative Airgun Survey Activity In The Beaufort Sea During Ice-Free Conditions, 2008-2012**

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Every year since 2007 a collection of at least 35 “Directional Autonomous Seafloor Acoustic Recorders” (DASARs) have been deployed across a 280 km swath of the Beaufort Sea continental shelf, in water depths between 15 and 50 m. The ability of these instruments to estimate the arrival azimuth of transient signals has facilitated the development of an automated algorithm for the detection of airgun survey activity, which has been applied to five field seasons of data. The contributions of airgun survey activity to the overall ambient noise background of the ice-free shallow-water Beaufort environment is quantified with a variety of metrics, in terms of both level (peak-to-peak, rms, sound exposure level), frequency, and time (intervals and fraction of time present). During some years, up to four airgun operations could be detected simultaneously, and a random one-second time sample yielded a 30% chance of containing an airgun signal, but the levels detected are generally within the bounds of natural wind-driven ambient noise levels, in situations where no local seismic survey activity is present. This dataset provides useful empirical insight into discussions about the cumulative contributions of distant seismic surveys to an environment extensively used by several marine mammal species. [Work sponsored by the Shell Exploration and Production Company.]

*Arctic - Mammals***Aerial Surveys Of Marine Mammals In The Colville River Delta (North Slope, AK)  
Using High-Resolution, Infrared Photography**

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Spotted seals have been observed historically in the Colville River Delta (CRD) and adjacent waters; however, there have been no published studies specifically addressing seal distribution or relative abundance in the CRD. In September 2013, we conducted the first dedicated, systematic aerial surveys for marine mammals in the CRD in order to improve our understanding of marine mammal (primarily pinniped) distribution and occurrence in the delta. In addition, these surveys employed remote sensing capabilities to assist visual observers in detecting marine mammals. Surveys were conducted in an east-west line-transect pattern, with transects spaced 1 nm apart. One survey was completed to verify and adjust protocol with three replicate surveys conducted from 10-13 of September at an altitude of 1,000 ft. In addition to flying pre-determined transect lines to achieve comprehensive coverage of the CRD, survey waypoints included known haulout locations based on historical data, primarily consisting of incidental seal sightings collected during other biological surveys of the area. The survey platform was a DA-42MPP aircraft equipped with an external nose-mounted TASE 400 HD camera system, including a mid-wave infrared (IR) imaging system and high-definition Electro Optical (EO) camera. Both of these features were used in-flight to assist onboard observers in detection of seal haulouts. Once animals were detected, the aircraft left the transect line to fly over animals to collect photographs and additional sighting data, including species, behavior, and environmental conditions. High-resolution, geo-referenced photographs were taken with an externally-mounted Nikon D800 camera, and these are currently being examined for more detailed species and group-size information. Preliminary data indicates a total of 5 seal haulout sites, and 6 sightings of unidentified pinnipeds observed in nearshore waters adjacent to the delta. Several haulout sites corresponded to those in the historical data, one of which was located approximately 52 km upriver from the Beaufort Sea. Spotted seals were the only pinniped species observed hauled out within the study area. No cetaceans were observed. The use of remote sensing technology and externally-mounted aerial photographic equipment is relatively new to marine mammal surveying. This innovative approach provides an alternative to traditional survey techniques.

*Arctic - Mammals***Pacific Walrus (*Odobenus Rosmarus Divergens*) Haul-Outs Along The Northwestern Alaskan Coastline, Summer And Fall 2009-2013**

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The Aerial Surveys of Arctic Marine Mammals (ASAMM) project, which is managed by NOAA and funded by BOEM, conducts flights in the northeastern Chukchi and western Beaufort seas (68°N -72°N, 140°W-169°W). Flights consist of line-transect surveys that cover a wide range, from the northern Alaskan coastline to a maximum of 315 km offshore, and they are designed to document the distribution, relative abundance, and behaviors of marine mammals in the Arctic during the ice-free season (July-October). Pacific walrus (*Odobenus rosmarus divergens*) are frequently encountered during flights in the northeastern Chukchi Sea, and are seen in the water, hauled out on sea ice, and, in recent years, in large aggregations on land. During aerial surveys conducted in summer and fall 2009-2013, we observed large walrus haul-outs along the northwestern Alaskan coastline in all years except 2012. Our initial encounters with coastal walrus haul-outs occurred in either mid-August (2011) or early to mid-September (2009, 2010, and 2013). While the location of haul-outs varied slightly between years (e.g., haul-outs were documented near Icy Cape in 2009 and Cape Lisburne in 2010), walrus consistently hauled out near Point Lay, Alaska in 2010, 2011, and 2013. The continued use of barrier islands near Point Lay for haul-out space suggests that it is important habitat for Pacific walrus, especially when sea ice habitat becomes less suitable. In 2009-2011 and 2013, years when coastal walrus haul-outs were observed, sea ice was either sparse or absent in the study area by late summer. In 2012, when no coastal walrus haul-outs were observed, diffuse sea ice persisted in the northern part of the study area near Hanna Shoal (~72°N, 162°W). The persistence of sea ice remnants near Hanna Shoal throughout the summer and fall of 2012, likely provided enough at-sea haul-out space, making land haul-outs unnecessary. The amount and location of Arctic sea ice during summer and fall, and its suitability as an offshore haul-out platform for walrus, will be critical predictors of the occurrence and timing of walrus haul-outs on land. Long-term, systematic aerial surveys along the coast can identify where and when walrus haul-outs form.

*Arctic - Mammals*

**Incidental Gross Necropsy Findings In Subsistence Harvested Ice Seals And Pacific Walrus.**

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Under the changing climate regime for the Arctic, shifts in ecological and subsequently epidemiological constraints are anticipated and expected to be altering morbidity and mortality rates among Arctic marine mammals; unfortunately natural causes of morbidity and mortality are generally not well documented for Arctic Marine Mammals. Ice seals (ringed, bearded, spotted seals) and Pacific walrus are very important subsistence species for Arctic coastal communities. As part of the North Slope Borough (NSB) ongoing Marine Mammal Health Research program, the department of wildlife management conducts necropsies and baseline tissue sampling on subsistence harvested marine mammals. We present some results from our 2011-2013 general ice seal and Pacific walrus subsistence harvest monitoring and sampling efforts due to hunter concern NOTE: Case reports (type I alopecia/delayed molt; type II ulcerative dermatitis, delayed molt etc.) from the ongoing 2011 Northern Pinniped unusual mortality event disease investigation were not included and will be reported elsewhere. Results: Incidental gross findings among the three species included: lesions of the reproductive system (adnexal cysts, uterine and penile melanosis, cliteromegaly, cryptorchism, retained placenta), endocrine system (thyroid cysts, adrenal nodules), musculoskeletal system (synovial cyst), integumentary system (panniculitis, epidermal molt (aka dreadlocks), skin sloughing) and digestive system (microdontia; chronic interstitial pancreatitis, hepatic cyst; cholestatic jaundice; geophagia). Helminths were commonly observed in the gastrointestinal system of ice seals, but not as commonly in the respiratory system. Ectoparasites i.e. lice were not observed. A variety of the observed pathological conditions (reproductive and endocrine lesions) are reported for the first time in Arctic Pinnipeds; however the majority of observed conditions in our material can be classified as benign and are mostly inconsequential to the health of the harvested animals. In the future this interpretation has to be periodically reevaluated in light of new case material. In conclusion, health studies of subsistence harvested pinnipeds in addition to stranded pinnipeds provide important baseline information for the health assessment of Arctic marine mammals. Quyanaqpak to the hunters of the North Slope and Bering Strait for participating in the ice seal and Pacific Walrus harvest monitoring program.

*Arctic - Mammals*

**Spatio-Temporal Movement Patterns Of Alaskan Beluga Whale (*Delphinapterus Leucas*) Populations Based On Vocal Peaks From Passive Acoustic Monitoring**

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Beluga whales (*Delphinapterus leucas*) are a conservation-dependent species due to their high vulnerability to overexploitation and other human activities. In Alaska, two subpopulations migrate annually from their predictable summering grounds in the eastern Chukchi and eastern Beaufort Seas, to overwinter in the Bering Sea. Determining the timing and migration route(s) in spring and autumn for each subpopulation requires additional information due to spatial and seasonal overlaps that complicate stock assessment and management. Belugas are highly vocal animals which make them ideal candidates for passive acoustic monitoring (PAM). To differentiate migratory streams we investigated temporal peaks in vocal activity from long-term acoustic recorders. Results include the temporal distribution of Alaskan beluga based on detections (Sep-2010 to Aug-2011) from passive acoustic recorders located 40 and 120 miles off Icy Cape in the eastern Chukchi Sea, 70 miles NE of Barrow along the 100 m isobath in the western Beaufort Sea, and 120 miles SW of St Lawrence Island in the Bering Sea. Belugas were detected sporadically throughout autumn in the western Beaufort and eastern Chukchi Seas, with a strong temporal migration peak in the inshore waters of the eastern Chukchi in late November. Winter detections were confined to the Bering Sea, except for sporadic eastern Chukchi detections. During spring, belugas were detected migrating through the eastern Chukchi in two distinct vocal peaks (early and late May). A mid-late May peak occurred in the western Beaufort; the timing suggests that these animals were from the first Chukchi peak and that migration of subpopulations can be discriminated when fine-scale spatio-temporal separation occurs. This study highlights the successful application of PAM of seasonal beluga movements to improve our understanding of stock structure for management and conservation. [Work supported by the National Research Council and Bureau of Ocean Energy Management].

*Arctic - Mammals***Bowhead Whale Diet: Bering To Beaufort Seas**

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This study examined the diet of bowhead whales (*Balaena mysticetus*) harvested by Alaska Natives near Barrow (western Beaufort Sea) and Kaktovik (eastern Alaskan Beaufort Sea) during 2007-2012. We additionally describe prey identified from bowhead stomach and/or fecal samples from bowhead whales harvested near Saint Lawrence Island in the northern Bering Sea. Our objectives were to: 1) identify the proportion of harvested whales that had been feeding; and 2) describe diet based on diet samples. Field examinations of 149 whales were conducted to determine the status of feeding as well as laboratory analyses of stomach content and fecal samples to describe the diet. During the fall, a higher proportion of animals had been feeding near Barrow (92%) than at Kaktovik (54%). A higher proportion of animals had been feeding near Barrow during the fall (92%) than the spring (10%). During the spring, a larger proportion of bowhead whales near Saint Lawrence Island (73%) were feeding than at Barrow (10%). There was no difference in the proportion of harvested whales feeding seasonally (spring 73% vs. fall 75%) near Saint Lawrence Island. Near Barrow, amphipods and mysids occurred more frequently in whales harvested during the fall than for whales harvested during the spring. During the fall, amphipods, fish, and euphausiids occurred more frequently in bowhead whales harvested near Barrow than whales harvested near Kaktovik. Near Saint Lawrence Island, euphausiids were the only prey taxa with a seasonal difference - occurring more in fall harvested whales. During the fall at Barrow, percent by volume during 2007-2009 were dominated by euphausiids (82%). During 2010, the dominant prey by volume switched to copepods (88%). A diversity of prey types dominated the fall 2011-2012 samples from Barrow and included isopods, mysids, copepods, amphipods, and fish. Our results are consistent with previous published literature that indicates bowhead whales feed regularly in the Alaskan Beaufort Sea during the autumn migration; however, there appears to be annual variation in the types of prey consumed. Additionally, results indicate the waters near Saint Lawrence Island are likely important areas of bowhead whale feeding activity.



*Arctic - Mammals***First Documentation Of Oil Fouling In Subsistence Harvested Ringed (*Phoca hispida*) And Spotted Seals (*Phoca largha*) In The Bering Strait Region – Fall 2012**

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During fall 2012, an oil spill of unknown origin was revealed in the Bering Strait region by the subsistence harvest of three oiled ice seals [spotted (n=2); ringed (n=1)]. Concurrently, several oiled seabirds (Common murre, crested auklet, and black-legged kittiwake) were located near Saint Lawrence Island. We present results of chemical contaminant analysis of tissues in oiled seals and associated gross necropsy and histological findings for three of the oiled seals, [2012-166 (spotted seal), N52-2012 (spotted seal) and N55-2012 (ringed seal)]. Petroleum exposure was determined by measuring polycyclic aromatic hydrocarbons (PAHs) or PAH metabolites in bile, blubber, liver, muscle, lung, and stomach content samples. Additionally results from biliary PAH metabolite analyses were used to determine PHN/NPH ratios that can help determine exposure to petroleum. Results: External signs of oiling varied among seals i.e. anatomical distribution, degree of oiling, and consistency of oil. Lesions were observed in the digestive, respiratory, and integumentary system; their relationship to oiling was inconclusive as tissue degradation, and repeated freezing and thawing introduced multiple artifacts. In general, overall PAH levels were relatively low (sum PAH < 50 ng/g, wet wt.) with higher blubber PAH concentrations measured in spotted seals vs. ringed seal. PAH equivalents measured in seal bile confirmed exposure to PAHs and were similar to, or higher, than those reported in oiled harbor seals collected in Prince William Sound, Alaska after the Exxon Valdez oil spill (EVOS). High bile protein values indicated non-feeding status of the oiled seals; Because PAH metabolites concentrate in the bile of non-feeding animals, bile PAH metabolite values in these oiled ice seals are most likely confounded by feeding status. Blubber PAH concentrations were lower than those measured in post EVOS oiled seals. PAH patterns (% of summed PAHs) of N52-2012 tissues showed petroleum exposure whereas tissue PAH patterns of N55-2012 and 2012-166 showed exposure to mixed PAH sources. This is the first case report of oil fouling in Alaskan ice seals. Oiled ice seals present a serious food security and potential food safety risk for Alaskan coastal communities that rely on marine mammal resources for cultural, nutritional, and economic needs.

*Arctic - Mammals***Using Airborne Lidar To Identify Potential Polar Bear Maternal Denning Habitat In Northern Alaska**

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Polar bears (*Ursus maritimus*) give birth to their young in winter dens that are excavated in snowdrifts. New-born cubs, which are unable to survive exposure to Arctic winter weather, require 2 – 3 months of the relatively warm, stable, and undisturbed environment of the den for their growth. In the southern Beaufort Sea (BS), polar bears may den on the Alaskan Arctic Coastal Plain (ACP) and the proportion of dens occurring on land has increased in recent years. Much of the ACP is currently used for oil and gas activities and proposed projects will likely expand this footprint in the near future. Petroleum exploration and development is heightened in the winter and this has the potential to disrupt maternal denning. However, maps showing the potential distribution of denning habitat can help mitigate negative interactions by identifying snowdrift-forming landscape features suitable for denning. We assessed the ability of airborne Light Detection and Ranging (LiDAR) data (2-m spatial resolution) to identify potential polar bear maternal denning habitat on the ACP. Our study region (1,400 km<sup>2</sup>) included the BS coast from the Prudhoe Bay oilfield in the west to near Point Thompson in the east and extended inland 10 – 30 km. The study area contained 12 known den locations, 51 field survey sites with bank heights and slopes typical of denning habitat, photo-interpreted denning habitat, and an IfSAR DTM (5-m spatial resolution). When compared to the known dens, the photo-interpreted dataset identified all 12 sites (100%), the classified IfSAR dataset identified 11 of the 12 sites (92%), and the classified LiDAR data identified all 12 sites (100%). When compared to the 51 field survey locations the photo-interpreted dataset correctly identified 88%, IfSAR 75%, and LiDAR 96% of survey locations. While all methods performed reasonably well, the LiDAR data performed best, and it resolved potential denning habitat along pingos, erosional landscape remnants, and other fine-terrain features that were undetected by photointerpretation or IfSAR. These comparisons highlight the utility of using LiDAR data for the automated identification of terrestrial polar bear maternal denning habitat.

*Arctic - Mammals***Recurrent Sightings Of Ice Seals Near An Offshore Exploratory Drill Rig In The Alaskan Beaufort Sea**

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Results for potential avoidance of offshore industry activities by ice seals in prior investigations have been mixed. Most of these studies, however, were associated with marine seismic surveys. During the Arctic open water season of 2012, Protected Species Observers (PSOs) aboard an exploratory drill rig in the Alaskan Beaufort Sea identified numerous bearded seals (*Erignathus barbatus*) and ringed seals (*Phoca hispida*) that were sighted repeatedly from late September through early November. Animals were observed singly and in groups as large as 21 individuals. Sighting durations for individual seals ranged from a few seconds to several hours; some animals were re-sighted daily for several days in a row. Seven distinct individual seals were identified using diagnostic features obtained from high-definition photographs taken during initial and subsequent sightings. Unique behaviors among the seven individuals also were used to aid in identification during re-sightings. The time periods from when each of these seven seals was first identified as a unique individual to the last sighting of each respective individual ranged from six to twenty four days, suggesting that at least some phocid seals took up temporary residency in the area near the drilling rig during exploratory drilling operations. Sightings and behaviors of recurrent seals are summarized and discussed in the context of overall pinniped sighting rates and activity of the drill rig. These data give valuable insight in to the distributions, ranges, and behaviors of ice seals in offshore areas away from landfast ice and their reactions to nearby industrial activities. Strategies to improve similar data collection in future years are also presented. A greater understanding of the distribution and behavior of seals near Arctic offshore exploration drilling activities will lead to improved monitoring and mitigation strategies and, ultimately, will reduce potential impacts to marine mammals from industry operations.

*Arctic - Mammals***Why One Year Is NEVER Enough – Comparison Of Bowhead Whale Distribution, Relative Abundance, Habitat Use And Behavior In The Western Beaufort Sea In July-August, 2012 And 2013.**

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Bowhead whale data collected during aerial surveys conducted in the western Beaufort Sea in summer 2013 were noticeably different from data collected during summer 2012. Funded by BOEM and conducted by NOAA, the Aerial Surveys of Arctic Marine Mammals (ASAMM) project encompasses a large (~107,000 km<sup>2</sup>) study area that includes continental shelf, slope and basin waters in the Beaufort Sea, between 140°W and 157°W. Broad-scale surveys have been conducted by ASAMM, and its predecessor BWASP, in this area in September and October since 1979. However, surveys in the western Beaufort Sea were flown for the first time in July and August in 2012 and replicated temporally and geographically in 2013. Surveys followed line-transect protocols, with randomly spaced transects oriented approximately north-south to bisect bowhead whale migratory paths. In 2012, 26 surveys were flown for a total of 28,500 km (14,000 km on transect), while in 2013, 23 surveys were flown for a total of 27,000 km (10,600 km on transect). There were 61 sightings of 118 bowhead whales in 2012 compared to 209 sightings of 383 bowhead whales in 2013. Variability was noted in bowhead whale relative abundance (0.005 whales per transect km in 2012; 0.022 whales per transect km in 2013), habitat use (predominantly slope in July and August 2012 versus slope in July 2013 and shelf in August 2013), and behavior. Eleven calves were seen in 2012 compared to 28 calves in 2013; 34 whales were observed milling or feeding in 2012 (29% of all bowheads seen) versus 129 whales (34% of all bowheads seen) in 2013. The limited effort (2 years) makes it difficult to know if variation observed between 2012 and 2013 is typical or unique; factors affecting bowhead whale occurrence could include feeding opportunities throughout the Beaufort Sea and anthropogenic influences. Continuing physical, biological and anthropogenic data collection throughout the Beaufort Sea in upcoming years will be crucial to gain a better understanding of bowhead whale distribution, density, and the variability therein in the western Beaufort Sea in summer. This information will become increasingly relevant for managing arctic resources and understanding the arctic ecosystem.

*Arctic - Mammals***Passive Acoustic, Visual, And Satellite Telemetry Results From The First ARCWEST Cruise, 2013**

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The Arctic Whale Ecology Study (ARCWEST) is a multi-disciplinary project that seeks to determine the relationship between currents and prey distribution in the Chukchi Sea, as well as to define the relationship between cetacean distribution and habitat use as it relates to prey availability within this area. To this end, CTD and zooplankton sampling as well as daytime visual and near-24 hour passive acoustic monitoring (sonobuoys) was conducted. In addition, archival implantable satellite tags were deployed on gray whales to determine movement patterns of individuals in the study area, and year-long passive acoustic, oceanographic, and zooplankton moorings were deployed. The combination of visual observations, passive acoustic monitoring, and satellite telemetry is extremely useful for evaluating the short-term distribution and movements of marine mammals, and these results are the focus of this poster. These visual-acoustic surveys complement data obtained by long-term moored recorders, and help contribute to the overarching goals of the ARCWEST study. The first ARCWEST survey took place from 13 August to 17 September, 2013 on the R/V Aquila. A total of 1,663 miles were visually observed, 248 sonobuoys were deployed (for a total of 346 hours of acoustic monitoring), and four satellite tags were deployed on gray whales. Results from the visual observations include a total of 220 sightings (421 individuals) of 7 confirmed cetacean species, 120 walrus sightings (1158 individuals), 17 sightings (721 individuals) of sea otters, and one polar bear sighting. The most common species acoustically detected were fin and humpback whales, detected on 70 and 24 (31% and 11%, respectively) of 225 successfully deployed buoys, followed by killer whales (8.5%) and gray whales (6.7%). Other species detected include bowhead whales (4%), walrus (5%), bearded seals (1%), and sperm whales (0.5%). Seismic airguns were detected on 2% of buoys. Spatial distribution maps of these visual and acoustic results will be presented as well as the individual movement tracks for the four gray whales satellite tagged off Point Hope. [Work supported by the Bureau of Ocean Energy Management]

*Arctic - Mammals***Identifying Hotspots For Bowhead Whales Of The Western Arctic Stock**

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The western Arctic stock of bowhead whales (*Balaena mysticetus*) ranges across the seasonally ice-covered waters of the Bering, Chukchi, and Beaufort seas. Declining sea ice has opened Arctic shipping lanes, facilitated oil and gas development, may expand commercial fisheries, and may affect the foraging ecology and conservation of this stock. We identified areas of concentrated use by bowhead whales, termed “hotspots,” and describe the timing of use and physical characteristics (oceanography, sea ice, and winds) associated with these areas. We used satellite locations from 55 bowhead whales, collected between 2006 and 2012, to map kernel densities across the stock’s range and defined hotspots as occurring within the 25% density isopleth; six primary hotspots were identified. In spring, most whales migrate to the Cape Bathurst polynya, Canada (Area 1); whales spent the most time in the vicinity of the halocline at depths between 30 and 100 m where zooplankton are presumed to aggregate. Whales were present in the polynya between 3 May and 9 July, and then most moved west to shallow waters adjacent to the Tuktoyaktuk Peninsula, Canada (Area 2), until 16 October, where wind-driven upwelling promotes the concentration of zooplankton. Between 22 August and 5 November, whales congregate near Point Barrow, Alaska (Area 3), where east winds promote upwelling that moves zooplankton onto the Beaufort shelf, and subsequent relaxation of these winds promotes their aggregation. Between 1 November and 15 January, whales congregate along the northern shore of Chukotka, Russia (Area 4), where zooplankton likely concentrate along a coastal front between the southeastward-flowing Siberian Coastal Current and northward-flowing Bering Sea waters. The two remaining hotspots occur in the Bering Sea: Anadyr Strait (Area 5), used between 1 December and 26 April, and the Gulf of Anadyr (Area 6), used between 17 December and 15 April; both areas exhibit highly fractured sea ice. Whales near the Gulf of Anadyr spent almost half of their time at depths between 75 and 100 m, where a subsurface front between cold Anadyr Water and warmer Bering Shelf Water is presumed to aggregate zooplankton.

*Arctic - Mammals*

**Traditional And Local Knowledge Of Small Scale Acoustic Disturbances To Marine Mammals: A Partnership Between Statoil And Three Alaskan Coastal Communities.**

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In an effort to avoid and minimize impacts on the Alaskan environment and people from proposed resource development projects, both industry and permitting agencies seek the “best available information” to inform their decision processes. In addition to western science, which has been used almost exclusively as an information source by these entities in the past, traditional and local knowledge is increasingly being recognized as a necessary and integral source of information. In response to both concerns about potential impacts to marine mammals from sounds generated by offshore oil development, and the request to consider local knowledge on the subject, a global oil company based in Norway, Statoil, partnered with three coastal communities to document local and traditional knowledge of small-scale acoustic disturbances to marine mammals.

Following the consent of local leadership entities, a Statoil marine biologist and an independent Alaskan marine biologist conducted ~70 interviews using the semi-directed method in Kotzebue, Point Hope and Wainwright, Alaska. With direction from local leadership and community advisors, experienced hunters and other people with good local knowledge were sought as interviewees, and questioned regarding all relevant marine mammal species and their experiences with behavioral reactions to sound, visual stimuli, smells, and other disturbances. Preliminary results indicate many similarities in observations of reactions to disturbance, with some regional differences. Behavioral responses to the same stimulus were often found to be consistent, some responses were variable, and many interviewees felt response was dependent on context. Ultimately, this research will be coalesced into a findings report divided by region, and after review by community partners, will be provided both to Statoil for incorporation into their risk assessment strategies, and to participating communities for use in their own decision making processes.

*Arctic - Mammals***Visual And Passive Acoustic Marine Mammal Monitoring In Northern U.S. And International Chukchi Sea Open Waters In Summer-Fall 2013**

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The receding Arctic summer ice edge has provided growing access to increasing human-related activities in northern U.S. and international waters of the Chukchi Sea and beyond. There is an accompanying growing need to understand how marine mammals (MM) use these waters and how such activities may impact them as required under the U.S. ESA and MMPA. However, few to no systematic MM surveys have occurred in these waters  $>72^{\circ}\text{N}$ ; most MM studies in the Chukchi Sea have focused on more southern waters associated with U.S. DOI-BOEM Lease Sale Area 193. As of early Oct 2013, TGS-NOPEC Geophysical Company had conducted approximately 4000 km of open-water (ice free) 2D seismic exploration surveys  $>91$  km (57 mi) offshore from Alaska in the Chukchi Sea. Over  $>1000$  km have been or are planned to be conducted above  $72^{\circ}\text{N}$  in U.S. and international open waters up to 700+ km offshore through October 2014 (ice permitting). Protected Species Observers (PSOs), including Iñupiat, observed for MM during full, reduced (during turns/transits between lines) and no seismic periods from the seismic vessel and a scout vessel. The scout vessel's primary responsibility is dedicated MM monitoring (M3) in front of the seismic vessel during all operations. Visual M3 occurred during daylight, and passive acoustic monitoring (PAM) occurred 24 hr/day only from the scout vessel using a towed hydrophone array. On each vessel, Mysticetus Observation Platform software was used to collect data and display real-time sighting locations relative to the respective vessel and/or seismic source location on a laptop PC monitor. As of early October, 232 sightings of ~399 individual MM had occurred, of which 56 sightings (24%) were seen  $>72^{\circ}\text{N}$ . Confirmed species sightings were primarily walrus followed by bowhead whale, spotted seal, minke whale, ringed seal, bearded seal, gray whale, and humpback whale, with no confirmed sightings of beluga whale. Line-transect density analyses using visual and acoustic detections will be conducted upon survey completion (sample size permitting). Data are important in contributing to sparsely available information on MM in northern Arctic waters previously largely inaccessible due to ice coverage.



*Arctic - Mammals***Gray Whale Calf Occurrence In The Alaskan Arctic, Summer And Fall 2013, With Comparisons To Previous Years**

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Marine mammal surveys were conducted in the northeastern Chukchi and western Beaufort seas (68-72°N and 140-169°W) from July to October, 2013, as part of the Aerial Surveys of Arctic Marine Mammals (ASAMM) project conducted by the National Marine Mammal Laboratory and funded by the Bureau of Ocean Energy Management. Previous aerial surveys in the northeastern Chukchi Sea were conducted by ASAMM, and previous projects, 1982-1991 and 2008-2012. In 2012 and 2013, gray whale (*Eschrichtius robustus*) calves were frequently sighted in the northeastern Chukchi Sea, and calf sightings were more numerous than recorded in previous years. In 2013, most gray whale calf sightings occurred in July (n=47); few calves were seen in August, September or October, similar to previous years. The spatial distribution of calves was also similar to previous years: primarily in ice-free, shallow water (<50 m) nearshore, along the Alaskan coast from Point Lay to just east of Point Barrow, with particularly high numbers near Wainwright and between Barrow and Point Franklin. This area is an important foraging ground for gray whales; feeding was the dominant behavior documented in this area throughout the survey years. It is possible that the shallow water along the northwestern Alaska coastline offers protection from predators; killer whales, known predators of gray whales, were sighted by ASAMM and others in multiple locations in the Chukchi Sea in 2012 and 2013. Shore-based surveys conducted along the California coast by the Southwest Fisheries Science Center during the annual northern migration found high gray whale calf counts in 2012 and 2013 compared with counts from previous years. It is possible that conditions were favorable for foraging in 2011-2013, allowing females to accumulate sufficient energy reserves to conceive in 2011 and 2012 and give birth and nurse their calves in 2012 and 2013. Additionally, other habitats where gray whale cow-calf pairs have been documented in the past, such as along the Chukotka Peninsula, may not have been as favorable to cow-calf pairs in 2012 and 2013.

*Arctic - Mammals***Gray Whale Foraging Habitats In The Alaskan Arctic, Summer And Fall 2009-2013**

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The northeastern Chukchi Sea contains summer foraging habitat for the Eastern North Pacific (ENP) stock of gray whales (*Eschrichtius robustus*). The presence and distribution of gray whales on summer and fall (July through October) feeding grounds located from 68-72°N and 155-169°W have been documented by the Aerial Surveys of Arctic Marine Mammals (ASAMM) project and its predecessor projects, currently funded by the Bureau of Ocean Energy Management and conducted by the National Marine Mammal Laboratory. Surveys were conducted periodically in the study area from 1982 to 1991, and 2008, but have been flown consistently during summer and fall 2009-2013. Gray whales are flexible and opportunistic foragers, feeding on abundant prey resources; they have been documented feeding on a variety of benthic invertebrates, in addition to pelagic organisms. When gray whales feed on benthic fauna, they suction prey and mud off the sea floor and strain the mud out through their baleen, resulting in a mud plume that is visible at the surface of the water and detectable by aerial observers. Feeding was the predominant behavior recorded for gray whales in 2009-2013 based on the presence of mud plumes at the surface. Feeding gray whales were sighted most frequently in July and were distributed primarily in three areas: 1) along the Alaskan coast from Point Barrow to Point Franklin, extending ~40 km from shore; 2) from Point Franklin to Icy Cape, along the coast and extending ~70 km from shore; and 3) west of Point Hope, extending ~90 km from shore. These distributions are similar to feeding gray whales documented in historical years (1982-1991) and 2008, with the exceptions that in historical years, gray whales extended only ~30 km offshore from Point Franklin to Icy Cape and were documented feeding near Hanna Shoal. The majority of feeding gray whales were in water with little to no sea ice and <200 m in depth. Results from these surveys indicate that the northeastern Chukchi Sea remains an important foraging ground for gray whales. It is recommended that these surveys be continued in order to document gray whale benthic foraging habitats in the future.

*Arctic - Mammals*

**Spectral And Temporal Characteristics Of Ribbon Seal Call Sequences In The Northeastern Chukchi Sea, 2008-2011**

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Ribbon seals (*Historiphoca fasciata*) produce repeated sequences of vocalizations that have been found in widely separated areas of their range and both within and outside of their breeding season. We present analyses of spectral and temporal characteristics of the Ribbon Seal call sequences recorded near St. Lawrence Island in 1967 and at offshore sites located 120 and 160 km off Point Barrow in the Chukchi Sea from 2008 to 2011. Call sequences were identified through visual inspection of spectrograms and then analyzed by logging key parameters of individual calls. We found two sequence types that were commonly repeated in all recordings during period of ribbon seal acoustic presence: the grunt-yowl-grunt-growl and roar-grunt. The order of vocalizations and inter-call intervals of the sequences were remarkably consistent during the 1967 breeding season in the Bering Sea and during the fall 2008 open water period in the offshore Chukchi Sea. This study shows that the acoustic behavior of ribbon seals is more complex than previously described and is very stable across widely separated samples. Our results also suggest that their vocalizations may be important for purposes other than breeding.

*Arctic - Mammals*

**Comparing Bearded Seal Vocalizations In The Canadian Arctic And NE Chukchi Sea, 1982 To 2010**

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This project compares bearded seal (*Erignathus barbatus*) vocalizations recorded from April through June in the offshore Chukchi Sea waters from 2008-2010 with acoustic recordings collected in April 1982 by Ian Stirling in the High Canadian Arctic (HCA) to look for geographic variation. The project goal is to quantify differences in the call types of bearded seals in two widely separated areas of the Arctic. The vocal repertoire of bearded seals in the HCA was more complex than in the Chukchi Sea, with more call types present. Calls in the HCA were also substantially longer duration and had more complex frequency structure. The complexity of the HCA calls required additional call parameters to be identified to describe the: including number of intra-call peaks and intra-peak inflections. Our results show large differences in call types of the trill category in different areas of the arctic. They also add to previous descriptions of bearded seal vocalizations in the High Canadian Arctic.

*Arctic - Mammals*

**Pacific walrus habitat use in the northern Bering and Chukchi Seas**

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The Pacific walrus is a large benthivore with an annual range extending across the continental shelves of the Bering and Chukchi Seas. We radio-tagged hundreds of walrus from 2006 to 2013, a period inclusive of rapid sea ice change in the Arctic, to assess walrus movements and foraging behaviors relative to benthic infaunal prey and sea ice. Within a prominent walrus wintering area in the Bering Sea (St. Lawrence Island polynya), walrus site selection was most strongly related to tellinid bivalve caloric biomass and sea ice concentration. Initial analyses in the U.S. Chukchi Sea indicate that areas of concentrated walrus foraging generally corresponded to regions with high bivalve biomass. An exception to this occurred when sea ice disappeared over the shelf in autumn in 5 of the last 7 years and female and young walrus hauled out on land in Alaska where near shore benthic prey was limited. These walrus spent more time swimming and less time foraging than walrus using customary offshore sea ice haul-outs. Additional radio-tagging in Russian waters is needed to further elucidate population-level behaviors.

*Arctic - Mammals*

### **Underwater Song And The Behavioral Contexts In Captive Bearded Seals**

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Bearded seals (*Erignathus barbatus*) largely rely on sea ice for their whole lives including breeding, feeding and resting. Therefore, negative effects of recent ice reduction have been concerned. Passive acoustic monitoring of marine mammals for their conservation became popular in recent years, but most of these works have just estimated the presence of animals. If we understand the behavioral contexts and function of vocalizations, we could get more useful information from the monitored sounds. Although there have been many studies on underwater vocalizations of bearded seals, little is known about the behavioral context, mainly because of the difficulty observing the behavior in the wild. In this study, we analyzed the relationship between underwater vocalization and behavior of captive bearded seals to estimate the function of their vocalizations. We recorded behavior and sounds of an adult male and two adult females in Otaru aquarium, Hokkaido, Japan between March 2012 and May 2013. Behavioral observation was conducted in the daytime focusing on social behavior. Underwater sounds were continuously recorded using a hydrophone (recording range: 20 Hz to 20 kHz) and a linear PCM recorder (sampling rate: 48 kHz). Although the previous studies speculated that only adult males vocalize, we found that females also frequently vocalized. The adult male vocalized from December until April with a peak in March, while the two females vocalized only in March, breeding season reported in the wild. The adult male produced 3 call types (trill, moan and high-moan), while the females produced 5 call types (moan, high-moan, growl, snort, and bell) associated with muzzling behaviors against the throat of the vocalizing male. These call types were often recorded in typical sequence that consist of solo-part by the male or female, and duet-part between the male and female. These results suggest that their vocalization is related to the courtship and/or territorial behavior in breeding season.

*Arctic - Mammals*

**Beluga Whale (*Delphinapterus Leucas*) Click Duration And Inter- Click Intervals In The Chukchi Sea Between Years 2006-2012**

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Belugas produce clicks for echolocation. Click durations and inter-click intervals may vary from one population to another or within a population, based upon behavior, habitat characteristics, prey type, or other factors. We analyze year-round acoustic recordings from the offshore Chukchi slope north of Pt. Barrow, Alaska, for the presence of beluga whistles and clicks. Beluga sounds were present offshore in fall, spring, and summer. Whistles were far more common than clicks, possibly due to limitations of system sample rate. We present a summary of click durations and inter-click intervals and compare these characteristics with previous studies of both wild and captive belugas.

*Arctic - Mammals*

**Bowhead Whale Seasonal Acoustic Presence And Behavior In The Bering And Chukchi Seas**

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Agviq, the animal commonly known as the bowhead whale (or *Balaena mysticetus* to the scientific community) is important for the culture and subsistence of Inupiaq people in the Alaskan Arctic. Traditional knowledge and scientific studies have found that different age classes of animals tend to move together in similar locations and times during the spring migration. Throughout the year, bowhead whales produce a repertoire of sounds that includes low and medium-frequency tonal calls and song; and the voices of these whales can be heard underwater as they migrate past coastal communities from the Bering to the Beaufort Sea. We analyze long-term acoustic recordings gathered in the central Bering and NE Chukchi Seas between 2005 and 2011 to look for seasonal or geographic variation in the acoustic behavior of this stock. The repertoire is presented for both locations, including spectrograms and descriptive statistics. We look for similarities and differences throughout the year and compare the sounds at both sites. Particular attention is paid to the relative proportions of call types during months of acoustic presence. We compare monthly changes in the acoustic repertoire from April through June to scientific and traditional ecological knowledge regarding timing of different age and sex classes passing Pt. Barrow.



*Arctic - Mammals***Methods For Assessing Response Of Marine Mammals To Cumulative Underwater Sounds**

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There are no standards for assessment of cumulative effects of disturbance. Projections of cumulative effects are complicated by variation in responses to human activities and to stressors created by those activities among, for example, species, sexes, life stages, and behaviors. We define stressors as entities or processes that have negative effects on individuals or populations within a given location and time period. Thus, stressors are defined relative to response variables. Previous quantitative assessments of cumulative effects of anthropogenic sound typically considered a single source whereas qualitative assessments may have included multiple sources but rarely identified response variables. As a step toward understanding cumulative effects of disturbance, we developed methods for quantitatively and qualitatively estimating exposure and potential responses of marine mammals to multiple sources of continuous and impulsive sound. Both methods have eight steps and are transferable among sound sources, ecosystems, and species or populations. In steps one through four of either method, one sets boundaries on the assessment and identifies response variables and covariates. The quantitative method then estimates which of these sources are likely to create stressors to given response variables, models sound fields, and models exposure and responses of the target animals. Results include estimates of both the population-level exposure to each sound source and the aggregated exposure to all sources. The qualitative method places greater emphasis on documenting major uncertainties about responses of a given species to particular activities or stressors. It also requires specification of alternative, a priori criteria for significant effects. Accordingly, there will be an explicit basis for determining whether animals have been harassed or harmed. As a proof of concept, we conducted a case study on migrating bowhead whales (*Balaena mysticetus*) in the Alaskan Beaufort Sea in autumn 2008. Maximum received sound exposure level at different water depths changed over time as human activities changed. Different sources dominated the sound field over time at any given location. Instantaneous and cumulative exposure depended on where animals swam relative to the shoreline and whether they averted from certain sound pressure levels. Our transferable methods increase the transparency of effects assessments.

*Arctic - Mammals*

**Seasonal Variation In Beluga Whistle Diversity And Detection Rate In NE Chukchi Sea**

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Belugas utilize Chukchi Sea continental slope waters during large portions of the year as they forage and move to and from other areas between coastal Alaska and the Arctic Basin. We recorded year-round acoustic data at a site 160 km NNW of Pt. Barrow, Alaska and analyzed them for the presence of beluga whistles. Density of beluga whistles per minute was counted for a subsample of detections in each month to enable rough comparisons of whistle density per period of acoustic presence. We also count the number of distinctly different whistle patterns in a given time period to estimate diversity of whistles. Comparison of these values for the periods of September-October 2009, April-May 2010, and June-July 2010 shows that although belugas are reliably present in each of these periods, whistle density and diversity are highest in summer months. We evaluate these potential seasonal differences in beluga acoustic behavior observed at the study site in light of known movements of Eastern Bering Sea and Beaufort Sea beluga stocks.

*Arctic - Mammals***Pacific Walrus Tusk Asymmetry And Sea Ice Extent****James MacCracken**, james\_maccracken@fws.gov

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Asymmetry of bilateral morphological traits has been related to habitat changes, nutritional status, body condition, genetic diversity, predation levels, pollution exposure, fitness, etc. in a variety of taxa. The U.S. Fish and Wildlife Service implemented a tusk tagging program under the Marine Mammal Protection Act for Pacific walrus (*Odobenus rosmarus divergens*) harvested by subsistence hunters in 1990. Since then over 40,000 tusks have been tagged and measured for length and basal circumference. We analyzed this data to: (1) determine which tusk measurement was least variable, (2) accurately assign tusks of unknown sex as male or female, and (3) examine tusk asymmetry in relation to recent habitat changes associated with climate change. Tusk basal circumference was least variable and normally distributed with females having a narrower range than males. Discriminant classification functions had an overall accuracy of 89% assigning unknown tusks to sex. Asymmetry in basal circumference was inversely related ( $R^2 = 0.91$ ) to minimum Arctic Ocean sea ice extent when lagged by 4 years supporting the assumption that recent habitat changes may be affecting individual condition. However, the individual fitness and population level consequences of this are unknown.

*Arctic - Mammals***Dive Behavior Of Bearded, Ribbon And Spotted Seals In The Bering And Chukchi Seas**

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Seventy-one satellite-linked archival tags were deployed on bearded (n=7), ribbon (n=42) and spotted seals (n=22) in the Bering and Chukchi seas between 2007 and 2012. In addition to location estimates, the tags also record and transmit summarized behavior data on the number of dives, time at depth and dive duration. Previous analyses of the seals' movements documented the different seasonal patterns of geographic spatial use by the three species. We used the dive behavior data to illustrate further differences between the species, in the use of the 3-dimensional space. Ribbon seals are the deepest diving of the three species with dives frequently deeper than 150 m and a few exceeding 600 m. The deeper dives are more commonly observed in the winter season when ribbon seals are off the shelf and associated with more pelagic habitats. Dive behavior of spotted seals and bearded seals are mostly confined to less than 150 m. These dive depths reflect the close association of bearded and spotted seals to shelf habitats. Most spotted seal dives are less than 70 m with deeper dives (150-200 m) observed mostly in the late winter and spring. Bearded seals distribute dives relatively evenly across depths to 150 m in the summer months while the winter months are strongly linked to the bathymetry of individual winter locations. Dive data from tags deployed on young-of-the-year ribbon seals also reflect the ontogeny of diving capabilities with increasing dive depths from June through October. The development of dive behavior in young animals and the plasticity in dive capabilities across all three species is an important component of our ability to understand and predict responses of ice-associated seals to dramatic changes in sea-ice and other elements of their marine ecosystems stemming from global climate change.

*Arctic - Mammals***Real-Time Acoustic Monitoring And Source Level Measurements Of Walrus In The Northeastern Chukchi Sea**

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The northeastern Chukchi Sea is a main feeding ground for herds of female and young Pacific walrus during the summer and autumn. Our understanding of their acoustic behavior has improved recently owing to large-scale passive acoustic monitoring (PAM) programs in the Chukchi Sea. Interpretation of the PAM data has nevertheless been hampered by incomplete characterization of walrus vocal behavior and source levels (SL; acoustic pressure at 1 m distance from a point source) in the wild. SL of knocking sounds have been measured for wild walrus in the Chukchi Sea (Mouy et al. 2012), but SL measurements for other call types have been derived from one captive adult male only (Reichmuth et al. 2009). In July 2013, we used two custom-built, real-time, directional, telemetered acoustic recording systems to record and localize vocally active walrus in the water near groups hauled out on ice in the northeastern Chukchi Sea. The range between the recorders, support skiff and calling animals was usually less than 200m and typically within a few tens of meters, allowing for simultaneous visual observations. Calling walrus were localized using cross-fixes of acoustic bearings. SL were measured for knock and bell calls and various grunting sounds by adding modeled frequency-dependent transmission losses to the received call band levels obtained from the calibrated recordings. Only calls with high signal-to-noise ratio were used in this analysis. Various age and sex classes were usually clustered and interacting in the water during the recording sessions, thereby preventing us from assigning calls to a given individual in most cases. Future work will aim at measuring SL for specific age/sex classes, particularly females and young. The improved characterisation of walrus vocal behavior obtained by this study may allow deriving density estimates from PAM data and will contribute to estimating walrus communication space and the effects of anthropogenic noise thereon.

*Arctic - Mammals***Results From Village-Based Walrus Studies In Alaska, 2013**

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Pacific walrus winter in the Bering Sea, but females and young summer in the Chukchi Sea resting on sea ice; most adult males remain in the Bering Sea where they rest on land. The rapid retreat of sea ice is changing summer walrus habitat in the Chukchi Sea and may be changing summer distributions and haulout behavior, requiring that walrus haul out on land when ice is not available. The purpose of this project is to work with subsistence walrus hunters to conduct observations at terrestrial haulouts accessible from coastal communities, deploy satellite-linked tags to monitor movements and feeding behavior, and to document local knowledge regarding terrestrial walrus haulouts. In preparation for a potential terrestrial haulout near Point Lay in 2013, local hunters assisted in the placement of camera towers. A relatively small haulout (1,500–4,000 walrus) that formed near Point Lay in mid-September and grew to ~10,000 in late September was monitored. Skiff surveys were conducted to look for other haulouts and for carcasses, when possible and without disturbing the haulouts. Traditional and local knowledge interviews were conducted in Point Hope and final reports are now available for Point Hope and for Wainwright and Point Lay, jointly. In association with a multi-agency walrus research cruise in June, walrus hunters from Saint Lawrence Island deployed 34 satellite-linked transmitters in the Bering and Chukchi seas. Of the 34 tagged walrus, 28 were females, (13 of which were accompanied by calves of the year) and six were adult males. Preliminary data show the highest concentration of tagged walrus occurred in the Hanna Shoal area within Lease Sale 193 in the eastern Chukchi Sea during July and August, however areas north of Wrangel Island and along the northern Chukotka coast, Russia were also used. All tagged walrus left Hanna Shoal during the first week of September. None of the five tags still transmitting in September were located at the terrestrial haulout near Point Lay, although one female hauled out on the Chukotka coast near Vankarem, Russia.

*Arctic - Mammals***You Are What You Eat? Differential Digestion And Modification Of Fatty Acids In The Digestive Tract Of Bowhead Whales**

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Bowhead whales (*Balaena mysticetus*) are a subsistence resource of cultural significance to Arctic Native communities. Bowheads are endangered baleen whales and rely on high density prey aggregations to efficiently acquire energy. Changing sea ice regimes in the Arctic affect primary productivity that may then propagate to biomass and nutritional quality of secondary consumers, including zooplankton prey of bowheads. We sampled alimentary tract content of subsistence-harvested bowheads (2009-2012) from forestomach, fundic and pyloric chambers, small and large intestine and assessed lipid assimilation efficiency based on “start” composition of forestomach content to “end” composition of colon content. Lipids were taken up along the duodenum with an efficiency of 50-60%. We then extracted and transesterified lipids from euphausiid and copepod prey and alimentary tract content (forestomach, jejunum, and colon) of 3 bowheads harvested during fall 2011 to identify if all prey fatty acids (FA) are assimilated with equal efficiency or if certain FAs are taken up preferentially. Fatty acid proportions of prey agreed with those found in the forestomach. During the digestive process, relative proportions of FAs changed significantly ( $P < 0.05$ ) along the alimentary tract with FAs generally becoming more saturated and elongated, and polyunsaturated FAs (PUFA) contributing less. Specifically, long chain saturated fatty acids (SAFA, e.g., 20:0 and 22:0) appear in the colon, but are not present in the diet pointing to bacterial synthesis in the gut. In contrast, polyunsaturated fatty acids (PUFA) are taken up, in particular essential fatty acids, such as 20:4w6, 20:4w3, and 22:6w3, do not occur in the colon. Hydrogenation and isomerization of monounsaturated FAs and PUFAs are known to occur in the rumen of farm animals leading to higher proportions of SAFAs. Prey fatty acids are therefore likely transformed before their uptake in the small intestine, thus amount and composition of FAs of mysticete prey differs from absorbed FAs. This could have implications for the usefulness of fatty acid signature analysis and description of fatty acids in the blubber of mysticetes for dietary analysis.

*Arctic - Mammals*

**Sounds Of Atlantic And Pacific Walrus: Historical And Geographic Comparison**

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Atlantic and Pacific walrus stocks may mix in Canadian and Alaskan Arctic regions in the future as sea ice decline continues. Acoustic data now recorded year-round in many locations throughout the Arctic may be useful for determining when and if this occurs. Each species produces a distinct variety of sounds, including patterned sequences of knocks and bell-like calls, which may be identified in autonomously recorded acoustic data. We analyzed recordings of Atlantic walrus sounds collected in the High Canadian Arctic in 1983 and recordings of Pacific Walrus made in the Bering Sea in 1967 and the NE Chukchi Sea in 2010. Repertoires of knock and bell sequences are presented for each location, along with high quality spectrograms and spectra. These analyses provide additional information to aid in future studies, looking at changes in the distribution and seasonal movements of walrus species.



*Arctic - Mammals***Current Status Of Ringed Seals In Alaska Using Harvest-Based Monitoring**

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Arctic sea ice has declined in extent, thickness, and duration; these declines are predicted to continue, along with a reduction in snow cover. Declines in snow cover and sea ice have been predicted to negatively affect body condition, productivity, and pup survival of ringed seals (*Pusa hispida*), which are dependent upon snow cover for the construction of pupping dens and sea ice for resting, pupping, and molting. There are no reliable estimates of ringed seal abundance or trend in Alaska; however, since 1960, the Alaska Department of Fish and Game has worked with Alaska Native hunters to collect data from the subsistence harvest that can be used as an index to population health and status. We examined population indices between 1960 and 2012 to determine if declines in sea ice are currently affecting ringed seals. From 2000 to 2009, sternal blubber thickness was consistent with the recent 50 year average; from 2010 to 2012, however, seals had thicker blubber (0.5 cm increase). Seals born during the 2000s (except for 2006) tended to be longer than average, suggesting that the growth rate has increased in recent years. Pregnancy rates have varied minimally since the 1960s (range: 76–89%); however, since 1999, the average age of maturity has been the youngest observed (3.2 years,  $P < 0.05$ ). Additionally, pups were harvested in greater proportions during the 2000s (56%) than before (31%), indicating that pups are being produced, weaned, and are surviving to be harvested. Although it may be too early to observe negative effects of climate change on ringed seals, due to lag effects or minimum sea ice thresholds, currently ringed seals in Alaska have more blubber, are larger, and show no reduction in productivity or pup survival as was predicted to occur with climate change.

*Arctic - Mammals*

**Modeling The Habitat Of Beluga Whales (*Delphinapterus Leucas*) And Arctic Cod (*Boreogadus Saida*): A Comparative Study Of Maxent And Nonparametric Multiplicative Regression**

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The known distribution of beluga whales (*Delphinapterus leucas*) ranges from sub-Arctic to Arctic waters where they migrate in gregarious pods, following the sea ice and other environmental predictors throughout the year (Heide-Jorgensen et al. 2009, Reid et al. 2003, Newson et al. 2008). There are five geographically distinct stocks of beluga whales surrounding Alaska. This study focuses on the Eastern Chukchi Sea stock due to its proximity to potential oil exploration and production sites and available data. Though past studies have examined the relationship between beluga whales and environmental predictors such as sea ice, little is known about the potential habitat range (O'Corry-Crowe et al. 1997). This study will develop potential summer habitat models for the Eastern Chukchi Sea stock of beluga whales using two approaches: Maxent and Nonparametric Multiplicative Regression (NPMR). Both modeling methods are relatively novel in habitat modeling and in the marine sciences. Furthermore, Arctic cod (*Boreogadus saida*) are common prey for beluga whales, therefore potential habitat models for Arctic cod will first be developed using the same approaches (Schiermeier, 2007, Krasnova et al. 2012, Hansen et al. 1999). Results from the Arctic cod models will then be implemented as environmental predictors in the beluga whale habitat models. 2007 was a record-breaking year for the reduction in the amount of sea ice so both Arctic cod and Belugas will be modeled separately before and after 2007. Results from Maxent and NPMR will be compared to examine the process, validation, and uncertainty of each approach. Results of this study will provide the potential habitat for Arctic cod and beluga whales, which could be used for better management practices for governments and resource-based industries in the Arctic. Predicting the potential habitat might also impact the culture and livelihood of indigenous groups, who rely on marine species as a cultural and consumable resource (Hassol, 2004). In addition, results from the model comparison will give valuable insight as the applications for predictive habitat modeling expand (Franklin, 2009).

*Arctic - Mammals***Modeling Western Arctic Bowhead Whale High-Use Areas In The Western Beaufort Sea, 2000-2012**

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Characteristics of western Arctic bowhead whale distribution vary spatially from the Bering to the Chukchi and Beaufort seas, and temporally across seasons. Quantitatively describing the variability in bowhead whale distribution can lead to insights into bowhead whale ecology and can inform conservation and management decisions. The spatial distribution of bowhead whales in the western Beaufort Sea (140o-156oW) in the fall (September and October) of 2000 through 2012 was quantitatively assessed using a geographically-explicit model of bowhead whale relative abundance (number of animals per kilometer) based on sightings made during the Aerial Surveys of Arctic Marine Mammals (ASAMM) line-transect surveys and preceding projects. ASAMM is currently funded by BOEM and conducted by NMFS. The analysis was restricted to the 2000-2012 ASAMM data because experts believe that a regime shift occurred in the Arctic around 2000-2002. The model was based on a grid with a 5 km x 5 km resolution and incorporated spatial heterogeneity in bowhead whale group size and survey effort. The model did not account for temporal variability in bowhead whale distribution or sighting probabilities, although those are natural extensions that could be built into future models. Bowhead whale high-use areas (HUAs) were identified as the locations of the 30th, 35th, 40th, 45th, 50th, 55th, 60th, 65th, and 70th quantiles of predicted bowhead whale relative abundance for each north/south column of 5 km x 5 km grid cells in the study area. For example, the location of the 30th quantile in a specific column of cells referred to the location where 30% of the predicted number of bowhead whales were closer to shore and 70% were farther offshore. The midpoints of all cells corresponding to each quantile were connected across the study area to define linear boundaries across the western Beaufort Sea corresponding to each quantile of the bowhead whale HUA. The resulting HUAs were located relatively nearshore from Dease Inlet to Cape Halkett and east of Kaktovik, Alaska, and they bordered the barrier islands between Cross and Flaxman islands, Alaska. The HUAs were relatively farther from shore north of Harrison and Camden bays, Alaska.

*Arctic - Mammals***Cetaceans in the Vankarem Cape region, Chukotka****Natalia Kryukova**, sea-walrus@list.ru

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Investigations were conducted from August to November 2010-2011 in the Vankarem Cape region, Chukotka (Russia). Observations lasted 151 days (> 60 hours). Scans of the water area were carried out daily from the shore (15 m height) and a lighthouse (25 m), once a day using Steiner Skipper 7x50 binoculars with a built-in compass. Distance to animals was estimated visually. 123 whales were registered during the observation period in 2010 and 133 in 2011. In 2010-2011, 96 and 77 bowhead whales (*Balaena mysticetus*) respectively were observed from September to November. Usually groups of whales were sighted during 3-4 days with an interval of 15-23 days. 2-25 whales stayed in the water area simultaneously. Maximum numbers of the whales were registered 09/14/2010 (25 individuals) and 10/21/2011 (24). Total numbers of observed gray whales (*Eschrichtius robustus*) were 18 in 2010 and 29 in 2011. Simultaneously 1-5 single grays were sighted in the area. They were observed with intervals of 1-16 days during the whole observation period, until the appearance of the first brash ice. Maximum observed numbers of grays were 3 individuals in 2010 (09/17, 10/01 and 10/11) and 5 individuals in 2011 (08/30). Killer whales (*Orcinus orca*) were sighted only in 2011 (21 animals). They appeared 3 times (08/19, 09/08 and 10/05) with an interval of 20-26 days. Size of their groups varied between 4-12 animals and in all cases they hunted walruses. Humpback whales (*Megaptera novaeangliae*) were observed rarely - totally 8 individuals were registered in 2010-2011 (basically in September and 1 sighting in October). Not more than two whales were registered in the area simultaneously; usually they were singles, once – a group of 2 animals. The most usual species in the coastal waters of the Vankarem Cape were gray whales, which were available there during the whole observation period. Sightings of bowhead whales had an intermittent (or wave-like) character that was associated with their migratory behavior. Killer whales appeared periodically, showing hunting behavior. Humpback whales were observed occasionally.

*Arctic - Mammals*

**Arctic Currents: A Year In The Life Of The Bowhead Whale**

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The University of Alaska Museum of the North is producing a 25-minute 3D computer animated film to tell the story of bowhead whale annual migration across the Bering, Chukchi, and Beaufort Seas. The film takes its narrative and title from the 2013 calendar, *A Year in the Life of Bowhead Whales*. The project is an outreach product based on a synthesis of interdisciplinary research and traditional knowledge. The purposes of the film are to improve public understanding of the marine ecosystem, with emphasis on the whales and their zooplankton prey. Specific topics covered include whale taxonomy, physiology, diet, behaviors, and migration through subarctic and arctic waters. All principal production and post-production services are being carried out by University of Alaska Museum of the North staff in collaboration with oceanographers, marine mammal biologists and Inupiat whalers who review topical elements of the production process. This presentation will include video clips of the film in progress, including illustrations of the modeling, animation, and scientific review process, and film finishing and distribution plans. Key themes will be the increased value of locally-directed production of culturally-relevant science outreach for local schools, community ownership of regionally-produced content, and the distributive power of working directly with multi-mode outreach destination institutions such as museums. The visual elements of the film center on 3D photorealistic animation of whales, copepods, and krill in arctic waters, as well as hemispheric-scale interpretation of bowhead whales' annual migration incorporating MODIS satellite imagery, aerial survey and satellite tagging data. Narration for the film will be recorded and presented in English, Inupiat, and St. Lawrence Island Yupik.

*Arctic - Mammals***Spatio-Temporal Distribution Of Bowhead Whales Off Barrow, Alaska: 2007-2012.**

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To minimize potential impacts from petroleum development activities in the Beaufort and Chukchi Seas, an increased understanding of bowhead whale behavior and distribution is needed. From 2007-2012, year-round autonomous passive acoustic recorders were deployed on subsurface moorings along the 100 m isobath from Point Barrow to Cape Halkett as part of the interdisciplinary Bowhead Whale Feeding Ecology Study (BOWFEST). These long-term recorders had a sampling rate of 8192 Hz and recorded on a 20-45% duty cycle. Over the course of the BOWFEST study period, 6056 days of data recordings were collected. All recordings were reviewed for bowhead whale signals manually, on a three-hour time interval. The spring migration was detected from 2009 through 2012 (earliest onset in 2011, latest in 2012). In all four years, a sudden and near-simultaneous onset of bowhead whale calling was observed at the long-term sites around the beginning of April. Fall migration was detected in all five years of the study. The main pulse of the fall migration, however, had a lower peak and was more compressed in time than the spring migration peak. The end of the main pulse of calling for the fall migration varied between early November (2007) to mid-November (2008 to 2011). Bowhead whale calls were recorded throughout the summer in the BOWFEST study area, not just during the spring and fall migrations, as had been previously believed. This can be seen most clearly in 2009 and 2011, where peak or near-peak presence continued between the migrations. [Work supported by BOEM/NOAA]

*Arctic - Mammals*

**Use Of Digital Imagery For Enumerating Walrus In High-Density Areas**

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During summer and fall of 2012, photographic aerial surveys were conducted at 305 and 457 m above sea level (asl) in de Havilland Twin Otters off the north and northwest coasts of Alaska. Offshore surveys were flown without protected species observers (PSOs) aboard the aircraft. During these surveys, two digital single lens reflex (DSLR) cameras were pointed obliquely to either side of the aircraft to monitor the area within 670 and 1000 m, at 305 and 457 m asl, respectively, on either side of the aircraft trackline. Imagery obtained in the offshore Chukchi Sea along the pack ice edge is presented to demonstrate the difference in walrus numbers that were identified by PSOs during a simulated survey (e.g., quick review of imagery via slide show) compared to the numbers that were detected during a more detailed review of the imagery with image enhancement. During situations when high densities of walrus were encountered, digital imagery provided a more accurate estimate of numbers of animals present. More accurate counts of large groups were also obtained from imagery than from PSO estimates made during brief views of animals during simulated surveys. Similar results were also found with PSO manned surveys versus imagery and in previous years when photographic images were used to supplement PSO count estimates of large walrus haul outs along the Alaska coast.

*Arctic - Mammals***Increased Onshore Behavior In Polar Bears During A Period Of Declining Summer Sea Ice Extent**

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The fate of polar bears (*Ursus maritimus*) is inexorably linked to the health of the Arctic ecosystem, particularly the availability of sea-ice habitat. Polar bears rely on sea ice to access prey, search for mates, and establish maternal dens. Unfortunately, the Arctic region is experiencing a warming trend that is unprecedented in historical records and driving dramatic changes in sea ice extent and structure and, in some cases, bear behavior. Since 2009, we have been studying the onshore behavior in polar bears from the southern Beaufort Sea during summer and fall. We have observed (i) an increase in the proportion of bears coming ashore during summer, (ii) trends of earlier arrival and longer tenure on land, and (iii) a shift in diet from ringed (*Pusa hispida*) and bearded seals (*Erignathus barbatus*) to human-provisioned bowhead whale remains. For a habitat specialist such as the polar bear, a rapidly changing physical environment can create a situation where the species becomes “trapped” by its evolved response to cues that are suddenly occurring in a novel context. As a result, long-evolved behaviors such as remaining with the summer sea ice as it declines can become maladaptive and eventually manifest at the population level as declining vital rates— unless the species possesses sufficient phenotypic plasticity to assess and respond to the novel conditions. We discuss the significance of the increase in onshore behavior, particularly as it relates to the long-term persistence of the southern Beaufort Sea polar bear population.



*Arctic - Mammals***Exploring The Relationship Between Gray Whale Distribution And Preferred Prey Species In The Northeastern Chukchi Sea**

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The relative immobility of gray whales' preferred prey may be a key parameter in long-term habitat use by whales. Through the Chukchi Sea Environmental Studies Program (CSESP), vessel-based marine mammal sighting data, vocalization detections, and benthic data were collected in the northeastern Chukchi Sea. We used CSESP and available historical benthic data from 1986 for exploratory analyses evaluating the relationship between eastern North Pacific gray whale (*Eschrichtius robustus*) distribution and amphipod prey biomass. We test the hypothesis that distributions of amphipods (preferred prey resources) are correlated with gray whale distribution in the northeastern Chukchi Sea. We quantified gray whale sighting rates (number of ind/hour) from 2,770 hours of visual observations collected during the 2008–2012 ice-free season and from vocalizations (presence/absence per day) recorded on bottom-mounted acoustic recorders during the 2011 and 2012 ice-free season. Visual data showed a higher gray whale sighting rate offshore of Wainwright ( $0.6 \pm 10.8$  ind/hour) versus farther offshore ( $0.005 \pm 0.08$  ind/hour). This pattern was confirmed by the gray whale vocalization data. Kriging maps displaying northeastern Chukchi Sea amphipod biomass (g/m<sup>2</sup>) distributions paired with visual and acoustic gray whale distribution maps showed that gray whale presence coincided with nearshore amphipod biomass of ~70-180 g/m<sup>2</sup>. Aerial survey data from 1982-1991 show that gray whales were commonly observed around Hanna Shoal, however, only few gray whales were visually or acoustically detected there in recent years.. Dense aggregations of benthic prey were noted at Hanna Shoal in 1988, but sampling effort in the same area in 2011 and 2012 did not reveal such aggregations, suggesting changes in offshore prey resources.. Relationships between food availability and marine mammal abundance are not always detectable. The higher gray whale presence nearshore versus offshore and the lower number of recent gray whale sightings near Hanna Shoal,, where prey resources have apparently declined, suggests that dense amphipod beds are, in fact, key indicators of gray whale distribution.

*Arctic - Seabirds*

**Foraging For Fish In A Melting Arctic: A Science Lesson About Climate Change**

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The long-term study of the breeding biology of Black Guillemots on Cooper Island, Alaska, 35 km east of Point Barrow, has become a valuable data set for monitoring long-term cycles and trends related to climate change. It also provides an easily understood climate-change narrative about how decreasing sea ice has hindered the ability of an arctic seabird to find fish for its nestlings. Based on this research, we have designed a hands-on investigation for elementary-school-age students to learn about climate change. This lesson introduces the life cycle of Black Guillemots, how they reproduce and the adaptations they are making to adjust to life in a warming Arctic with less prey to feed their young. In this active investigation, students simulate the foraging trips parent birds make from their breeding colony to the pack ice and how the increased sea ice retreat affects this process. We present the student activity and learning objectives, as well as an assessment of learning outcomes. The lesson plan was developed during a 2012 Arctic Ocean Ecosystem Workshop held by ARCUS (Arctic Research Consortium of the U.S.) and COSEE (Center for Ocean Sciences Education Excellence) in Barrow, Alaska in May 2012. We also share our collaborative experiences presenting the lesson plan to a North Slope village classroom and a classroom in Seattle, WA. This poster is designed to highlight how current scientific research can be taught in elementary classrooms.

*Arctic - Seabirds*

**Sensitivity To Hydrocarbons And Baselines Of Exposure In Marine Birds On The Chukchi And Beaufort Seas**

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With prospects of increasing development of oil and gas resources and commercial shipping in the Chukchi and Beaufort seas, establishing baselines and assessing sensitivity of Arctic wildlife to hydrocarbon exposure will provide essential information needed for management and conservation for species potentially impacted by an oil spill. Using a broad selection of marine birds we will use species-specific cell culture to assess hydrocarbon sensitivity by measuring liver cytochrome P450 (CYP1A) activity using 7-ethoxyresorufin-O-deethylase (EROD). Currently, we have tested assay reagents (e.g. dimethyl sulfoxide) for non-specific toxicity and used positive control reference reagents (e.g., chrysene) to establish baseline responses for cell lines in selected arctic marine bird species and two control species (mallard and chicken). EROD responses and visual cellular cytopathic changes for each species were measured after a reagent dose exposure time of 24hrs. Results indicate differences in species response to control reagents. Future laboratory work will involve additional species, dose concentrations, and exposure times to evaluate the degree and duration of CYP1A induction to compare species sensitivity. Additional future work will include establishing baselines of current hydrocarbon exposure by testing livers from three marine birds of subsistence importance (king and common eider, greater white-fronted goose) by validating field sample collection methods and measuring liver CYP1A activity using EROD. Once complete, cell culture sensitivity and liver baseline exposure results from this project will provide valuable tools for monitoring marine bird populations, identifying sensitive species, and provide information and tools for future Natural Resources Damage Assessment in the event of an oil spill.

*Arctic - Seabirds***Egg Volume Decline Of Black Guillemot (*Cepphus Grylle Mandti*) Is Correlated With The Pacific Decadal Oscillation**

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Major physical changes have occurred in the Arctic Ocean in recent decades associated with increasing atmospheric temperatures. Dramatic reductions in summer ice extent and increases in sea surface temperature have been well documented through remote sensing, but our knowledge of the resulting effects on the region's marine ecosystems are limited, as seasonal sea ice and a paucity of sampling platforms continues to hinder oceanographic research. Seabird breeding colonies offer a unique and relatively inexpensive opportunity for land-based research on a marine ecosystem. Cooper Island, 35 km east of Point Barrow, supports a breeding colony of Black Guillemots (*Cepphus grylle mandti*) that has been monitored since 1975. Black Guillemots are one of the few resident seabird species in the Arctic and, as an upper trophic level marine predator, provide an excellent monitor of temporal variation in the region's marine ecosystems. The historical dataset from Cooper Island allows examination of past variation in the marine environment and facilitates informed interpretation of ongoing and future changes. We examined factors contributing to a decline in egg volume over a 34-year period (1978-2012), with mean egg volume for the colony experiencing an arch-like change, peaking in 1995. Generalized linear mixed models yielded significant positive correlations between egg volume and the body mass and breeding experience of the adult female and the Pacific Decadal Oscillation with a one-year lag. There was a significant negative relationship between egg volume and lay date. Annual variation in egg size in seabirds reflects both pre-laying prey availability and female condition. Recent decreases in egg size in the Atlantic Puffin (*Fratercula arctica*) have been shown to be related to changes in forage fish populations and climatic conditions. Our observed decrease in guillemot egg volume began in the late 1990s, concurrent with the start of major changes in regional sea ice extent and composition. Arctic Cod (*Boreogadus saida*) is the Black Guillemot's preferred prey and is closely associated with sea ice habitats. The observed decline in guillemot egg volume could reflect decreased abundance or availability of that keystone species and demonstrates the utility of monitoring that variable in the future.

*Arctic - Seabirds***Quantification Of Immunoglobulin G Levels In Eider Egg Yolk**

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The populations of Steller's and spectacled eiders have significantly declined, and spectacled eiders and the Alaska breeding Steller's eiders are listed as threatened under the Endangered Species Act. In Alaska, the eiders breed in the Yukon-Kuskokwim Delta or on the Arctic coastal tundra. In birds, the newly hatched are especially vulnerable to infection because they have an immature immune system and depend on maternal immunoglobulins (Ig) transferred from the yolk. For eiders, determining the susceptibility level of ducklings to disease is important for conservation of both species, therefore, maternal investment of IgG in yolk was investigated. Yolk samples have been collected from eggs laid by captive spectacled and Steller's eiders at the Alaska SeaLife Center during the breeding seasons of 2007-2013. This project had three objectives: 1) measure the IgG content of the eider egg yolk, 2) determine if IgG levels varied within a hen's clutch, and 3) determine if average IgG levels of hen's eggs varied between years. We hypothesized that the first egg in a hen's clutch would contain the highest levels of IgG and that levels would decline between early and later laid eggs. Initial findings suggest that IgG levels within a clutch are variable and not related to the order within the clutch. The average IgG content of yolk also varied between years for most hens. Immunoglobulin G levels typically ranged between 0.2 and 0.4 mg/ml in the yolk, but some hens laid eggs that contained levels above or below that range. This project established IgG baselines in eggs from eider hens maintained in a relatively controlled environment.

*Bering Sea - Climate and Oceanography***Oceanographic Habitat Conditions Along The Eastern Bering Sea Slope**

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Rising temperature, decreased dissolved oxygen, rising CO<sub>2</sub> and lower pH levels, are predicted environmental changes for the North Pacific due to climate change. Fish and invertebrate response to a changing marine environment is an emerging question for scientists and an important aspect of ecosystem management. Through environmental monitoring and amassing time series data we can begin to track changes in the environment and associated faunal response. I used the platform of the eastern Bering Sea upper continental slope groundfish survey conducted by the Alaska Fisheries Science Center to examine the relationship between fish and invertebrate distribution with oceanographic habitat conditions of depth, temperature, light, salinity, pH, oxygen, and turbidity. Shallow slope (<~550 m) environmental conditions were characterized as having higher variability and a linear relationship with depth while deeper slope (>~550 m) conditions were more uniform and nearly monotonic with depth. Further partitioning of the slope into a northern (>57 °N) and southern (<57 °N) component suggested that oceanographic conditions were significantly different between the north and south. Multivariate analysis showed temperature and salinity were important factors for shallow dwelling species while light, oxygen, and pH were important for deeper species. The general pattern showed shallow fauna experienced a greater change in habitat conditions than the deeper fauna with features such as light and oxygen as potential driving forces for latitudinal-depth distributions.

*Bering Sea - Climate and Oceanography***A Comparison Of Relative Zooplankton Abundance And Water Mass Type At Three Bering Sea Moorings**

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Pathways of zooplankton advection through the Bering Strait may be indicators of bowhead whale migration routes, aggregation trends, and feeding patterns. Such pathways can be identified using Acoustic Doppler Current Profiler (ADCP) data to find areas of high diel vertical migration (DVM), which is characteristic of bowhead prey zooplankton species, such as *Thysanoessa raschii* and *T. inermis*. These species have been found in the stomachs of bowhead whales near Barrow and in the Beaufort Sea but are not believed to be endemic to Arctic. It is assumed that the euphausiid population of the Beaufort Sea originates in the Bering Sea and is advected through the Bering Strait, but it is unclear where in the Bering Sea the zooplankton originate. Water masses within the northern Bering Sea are easily distinguishable and can be useful in determining advection pathways. Two years (2008-2009) of data from three ADCP moorings in the northern Bering Sea are analyzed to identify timing of highest acoustic backscatter in relation to water mass properties to determine relative zooplankton abundance distribution. Water masses are identified based on current speeds and temperatures averaged over 24 hour windows, and subsequently correlated with backscatter patterns for the same time periods. Previous results indicated higher zooplankton abundance and greater variation in DVM at the westernmost mooring during both years, suggesting greater zooplankton transport in Bering Shelf waters than in Alaskan Coastal waters. Current results reinforce these findings and suggest the western Bering Sea as a more probable source for zooplankton advection.

*Bering Sea - Climate and Oceanography*

**How Do Oceanographic Characteristics In The Northern Bering Sea Relate To Juvenile Salmon Biomass?**

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The oceanography and shelf dynamics of the southern eastern Bering Sea (EBS) have been well-studied, while less attention has been given to the northern EBS, although commercially important fisheries are present in both the south and the north. Sea ice extent and duration, and freshwater inputs from the Yukon River are substantially higher in the north compared to the south, resulting in large variations in oceanography between the northern and southern EBS and between regions within the northern EBS. Our goal is to describe spatial and inter-annual variations in oceanographic characteristics (currents, salinity, temperature, and zooplankton abundance) for pre-defined regions (Ortiz et al. in press), and compare these characteristics to juvenile salmon biomass (all species combined) in the northern EBS. Initial findings indicate that juvenile salmon biomass varies with small and large zooplankton abundance, bottom temperature and salinity, depending on region.



*Bering Sea - Climate and Oceanography*

**Volume, Heat And Salt Transport In The North-Eastern Bering Sea During 2007-2010 Derived Through The 4dvar Data Assimilation Of The In Situ And Satellite Observation.**

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The circulation in the North-Eastern Bering Sea was reconstructed through the 4Dvar data assimilation into the two nested models with spatial resolution of 15km and 7km respectively. The variety of assimilated data includes both in situ (e.g., temperature, salinity, velocity, surface drifters) and satellite (Sea Surface Height (SSH), Sea Surface Temperature (SST), ice concentration, velocity) observations. Our results indicate significant intensification of the Bering Slope Current in winter and stronger variability of circulation over the Eastern Shelf during the summer and fall. Analysis of the obtained circulation patterns allows accurate estimates of major transports. Our analysis indicates that during 2007, 2008, and 2009, approximately 90 % of Bering Strait flow originated from the Anadyr Strait, while flow through the Spanberg Strait contributed only 10 % to the total volume transport into the Arctic Ocean. This differs from previous (80 % and 20 %, respectively) partition of the Bering Strait transport but agrees well with reanalysis data from the Arctic Cap/HYCOM data assimilation system.

*Bering Sea - Climate and Oceanography***Towards Understanding Cross-Shelf Exchange in the Bering Canyon**

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Shelf-basin exchange is widely recognized as having an important influence on the ecosystem of the eastern Bering Sea. Shelf-basin exchange in the Bering Sea is highly heterogeneous, with enhanced cross-shelf transport associated with submarine canyons. Processes responsible for such enhancement include the interaction of ocean currents, tides, and eddies with bottom topography, but the relative importance and variability of these mechanisms are not well understood. We combine in situ measurements and numerical simulations to study shelf-basin exchange over Bering Canyon, the southernmost canyon along the eastern Bering Sea shelf-break. Our goal is to identify key processes that control cross-isobath flow and how these processes vary episodically and seasonally. Bering Canyon sits adjacent to Unimak Pass, the only conduit between the shelves of the eastern Bering Sea and the Gulf of Alaska. Thus the region's physical oceanography can be influenced by processes both north and south of the Aleutian Island chain. Hydrographic data have been collected on more than ten occasions from a region enclosing Unimak Pass. These data are used to examine water properties indicative of shelf-basin exchange, information that can inform interpretation of model results. Preliminary results from ROMS (Regional Ocean Modeling System) indicate intrusions of high salinity basin water from Bering Canyon onto the shelf as the season progresses from spring through fall. Flow through Unimak Pass is predominantly northward from the Gulf of Alaska to the Bering Sea on the eastern side of the pass; while on the western side, flow alters directions on synoptic time scales. Using model output, we will discuss the influence of various processes (tides, Unimak Pass fluxes, etc.) influencing shelf-basin exchange in the region.

*Bering Sea - Fish and Fish Habitat*

**Age, Growth, And Sexual Maturity Of The Deepsea Skate, *Bathyraja Abyssicola* (Gilbert 1896)**

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Title: Age, Growth, and Sexual Maturity of the Deepsea Skate, *Bathyraja abyssicola* (Gilbert 1896) Authors: Cameron M. Provost 1, Dr. David A. Ebert 4, Dr. Kenneth J. Goldman 2, Dr. Bradley P. Harris 1, and Dr. Cindy A. Tribuzio 3 Institutions: 1. Alaska Pacific University, Fisheries Aquatic Science and Technology (FAST) Laboratory 2. Alaska Department of Fish & Game 3. NOAA- Auke Bay Lab 4. California State University - Moss Landing Marine Laboratories and Pacific Shark Research Center Our understanding of the age, growth, and sexual maturity traits of many elasmobranch fishes is growing. This study aims to validate age determination using vertebral centra and caudal thorns, determine size at age, and determine maturity at size and age in the deepsea skate, *Bathyraja abyssicola*. Sex, maturity, total length, thorns, and vertebra were collected from 52 specimens taken on National Marine Fisheries Service cruises between the years 2001 and 2012. First, we aim to define annual banding patterns in vertebral centra with gross sectioning and histology and in caudal thorns using surface stains. Once annuli are detected an array of size at age models will be assessed to determine which best describes deepsea skate growth characteristics. Next, sexual maturity information from each specimen will be used to establish maturity at size/age ranges. These Rajiformes are found in deep waters (350 - 3000 meters) from northern Baja, California to the Bering Sea, and may occur as bycatch in the deep sea fisheries. This project will provide the first assessment of *bathyraja abyssicola* age, growth, and sexual maturity traits; information needed for informed skate management.

*Bering Sea - Fish and Fish Habitat*

**Conservation Engineering Outreach: Curriculum Development And Evaluation Of “Smart Fishing In The Bering Sea”**

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Authors: Christine Simpson<sup>1,2</sup>, Dr. Michael Kaplan<sup>1</sup>, Dr. Richard Murphy<sup>3</sup>, and Dr. Brad Harris<sup>2</sup> Institution<sup>1</sup>: Alaska Pacific University, Masters of Science in Outdoor and Environmental Education (MSOEE) Program Institution<sup>2</sup>: Alaska Pacific University, Fisheries Aquatic Science & Technology (FAST) Laboratory Institution<sup>3</sup>: Ocean Futures Society (OFS) Title: Conservation Engineering Outreach: Curriculum Development and Evaluation of “Smart Fishing in the Bering Sea” A 6th-12th grade conservation engineering curriculum, Smart Fishing in the Bering Sea, is being developed under an NPBR-funded project (# 1319) entitled “Benthic impacts of raised groundgear for the Bering Sea pollock fishery”. Fisheries researchers from NOAA-AFSC and Alaska Pacific University are collaborating programmatically with fishing and gear manufacturing industry members to address bycatch, habitat impacts, fuel consumption and pollock catch efficiency challenges facing the United States’ Pollock fishery. The purpose of the Smart Fishing in the Bering Sea outreach program is to increase ecological knowledge of the Bering Sea, enhance awareness of current commercial fishing trawl practices, and improve students’ ability to creatively solve problems through conservation engineering. The learning activities and outcomes of the program will be assessed using Outcomes-Based Evaluation and the final curriculum will be available for educators. Effectively communicating contemporary science is as important as the research itself. However, this is challenging because the subject matters are complex and dynamic. This can lead to an emphasis on the problem instead of solutions. The Smart Fishing in the Bering Sea curriculum aims to increase students’ ocean literacy and to enhance their ability to innovate in the face of tough fisheries challenges like bycatch and habitat impacts. Interactive and hands-on curricula material is being developed in collaboration with teachers from numerous private and public institutions in accordance with Alaska’s Science, Technology, History, and Mathematics content and performance standards and the National Science, Geography, and Mathematics Education Standards. Outreach lessons will include, Bering Sea Ecosystem: Marine Food Web Mural, Commercial Trawl Fishing in the Bering Sea, and Smart Fishing in the Bering Sea.

*Bering Sea - Fish and Fish Habitat***Predicting Settlement Success Of Two Slope-Spawning Flatfish In The Eastern Bering Sea**

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Changes in prevailing ocean currents can influence dispersal pathways during the early life stages of marine fish – a process known to play an important role in determining variations in settlement in flatfish. The slope-spawning flatfishes Greenland halibut (GH, *Reinhardtius hippoglossoides*) and Pacific halibut (PH, *Hippoglossus stenolepis*) are two ecologically and commercially important species in the eastern Bering Sea (EBS). These species may be particularly vulnerable to changes in ocean circulation because of their relatively long pelagic larval durations, which provide a protracted opportunity for unfavorable or interrupted transport. Although GH and PH share several life history attributes, species-specific differences in their pelagic durations, water depths during ontogeny, and specific habitat requirements under the same environmental forcing could result in differences in their dispersal pathways, which in turn, can influence their ability to successfully reach settlement locations on the continental shelf. We hypothesized that interannual variability in currents encountered by the species-specific early life stages may differentially affect GH and PH settlement success. To test this hypothesis, we combined biophysical modeling, synthesis of field data, and statistical analysis to: 1) identify settlement areas for GH and PH in the EBS using a generalized additive model (GAM), 2) simulate the dispersal pathways from spawning to settling locations for years 1982 to 2004, 3) examine the environmental factors influencing the interannual variability of predicted GH and PH settlement, and 4) assess the sensitivity of the model simulations to changes in spawning date and location for two environmentally contrasting years. Our results indicate substantial variability in GH and PH settlement success among years. Correlation analyses between settlement and transport along and across the EBS slope support our hypothesis that interannual variability in GH and PH settlement is caused by interaction between behavioral differences during early life history and circulation patterns in the EBS that differentially affect the two species. Our study constitutes a significant methodological improvement upon previous biophysical modeling of larval dispersal and settlement in the region, and uses a statistical approach that allows for preferential settlement in known nursery locations identified through field sampling.

*Bering Sea - Fish and Fish Habitat***Skate Nursery HAPC Designation In The Eastern Bering Sea**

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Skates exhibit K life history strategies and depend on high juvenile survivorship and recruitment for sustained healthy populations. Skate nurseries are areas of exceptional skate productivity and essential for successful skate reproduction. The protracted embryo development (>3 years) and low fecundity substantially increases the exposure of embryos to predation and disturbances at nursery sites. In 2010, six skate nursery areas were proposed as Habitat Areas of Particular Concern (HAPC) in response to a Request for Proposals (RFP) by the North Pacific Fisheries Management Council (NPFMC). Specifically, HAPCs are geographic sites that fall within the distribution of Essential Fish Habitat (EFH) for species managed under a Fishery Management Plan (FMP). The six HAPCs are comprised of 8 skate nursery sites for three of the most abundant skate species in the EBS: Aleutian (*Bathyraja aleutica*), Alaska (*B. parmifera*), and Bering (*B. interrupta*) skates. After public review, the NPFMC choose to designate the six HAPCs, request NMFS monitor these HAPCs for changes in egg density, and add skate research and monitoring to their Research Priorities list. Lastly, no protective measures, such as gear or area restrictions were taken at this time. The recognition of these sites as HAPC highlights the importance of this essential fish habitat for conservation, providing a platform for closer monitoring of disturbances causing detrimental effects (i.e. fishing, drilling, dredging). We believe the habitat designation will provide, at the least, a broader understanding of the importance of these sites and emphasize the need for further research and monitoring to ensure healthy skate populations and sustainable fisheries as designated under the Magnuson-Stevens Fishery Conservation and Management Act.

*Bering Sea - Fish and Fish Habitat***Estimating BMSY For BSAI Crab Stocks**

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The US Sustainable Fisheries Act requires Overfishing Limits for all managed stocks and evaluations of whether stocks are in overfished states or subject to overfishing. Overfishing is defined relative to the fishing mortality corresponding to MSY, FMSY, while being in an overfished state relates to stock biomass relative to the biomass corresponding to MSY, BMSY. FMSY and BMSY are impossible to estimate for most US fish and invertebrate stocks. Consequently, management advice for Bering Sea and Aleutian Islands (BSAI) crab stocks is based on “proxies”, such as that FMSY is ~ F35%. Furthermore, BMSY should be defined under prevailing environmental conditions, which implies using only past data under current environmental conditions to estimate BMSY. Assessments for five BSAI crab stocks are used to evaluate the estimates of BMSY from a variety of methods for calculating BMSY proxies. Analyses based on fitting stock-recruitment relationships to the estimates of recruitment and mature male biomass from these assessments suggest that the assumption FMSY=F35% is generally reasonable, but that the stock and recruitment data do not generally support the current BMSY values. Changes over time in average recruitment and in the form of the stock-recruitment relationship were found for most stocks. Of the methods considered, fitting stock-recruitment relationships and exploring whether they have changed over time appears the most promising approach. The dynamic B0 method also appears promising, but there is considerable uncertainty in BMSY values between harvest control rules, and assumptions regarding how recruitment is adjusted given changes in mature male biomass.

*Bering Sea - Fish and Fish Habitat*

**Oceanic Dispersal And Behavior Of Chinook Salmon In The Bering Sea**

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Information about the oceanic migration and behavior of fishes is important for understanding population dynamics and informing fisheries management, yet little is known about Chinook salmon in the Bering Sea. To rectify this important gap in knowledge, we are conducting a proof-of-concept study in which large, immature Chinook salmon (>60 cm) are captured by a chartered sportfishing vessel near Dutch Harbor, Alaska and tagged with pop-up satellite archival transmitting tags. While externally attached to the fish, the tags measure and record ambient light (for daily geolocation estimates), depth and temperature data. On a pre-programmed date during the following spring, the tags release from the fish, float to the surface of the ocean and transmit the recorded data to overhead satellites which are then retrieved by project investigators. This presentation describes the methods used during our first field season in 2013 and future plans for tag deployments in 2014.



*Bering Sea - Fish and Fish Habitat***Relationship Between Feeding Trophic Level On Total Mercury Concentrations In 5 Steller Sea Lion Prey Species.**

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Total mercury concentrations [THg] were measured in 5 Steller sea lion finfish prey species collected in the eastern Aleutian Islands to determine if the amount and/or variation in mercury in select prey could explain the wide range of [THg] in sea lion pup hair and blood (Castellini et al., 2012; Rea et al., 2013). Atka mackerel (ATMA; *Pleurogrammus monopterygius*), Pacific cod (PACO; *Gadus macrocephalus*), walleye pollock (WAPO; *Theragra chalcogramma*), arrowtooth flounder (ARFL; *Atheresthes stomias*), and Kamchatka flounder (KAFL; *Atheresthes evermanni*) are known, or suspected, Steller sea lion diet items and thus were chosen as the first focal prey species for this preliminary study. Fish samples (20 individuals per species) were collected and donated by Ocean Peace Inc. from winter 2013 commercial operations in fisheries management area 541. Fish were frozen whole at sea and subsampled at the UAF Wildlife Toxicology Lab for mercury and stable isotope ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) analyses. The [THg] increased with fork length (fish length) and mass in PACO, KAFL, ATMA and ARFL ( $p < 0.05$ ) suggesting mercury bioaccumulates with age. PACO and KAFL showed significantly higher [THg] than WAPO, ATMA, and ARFL ( $p < 0.05$ ) although no concentrations exceeded  $0.18 \mu\text{g/g}$ , ww. Thresholds of concern for human consumption of fish are  $1 \mu\text{g/g}$ , ww. More enriched stable nitrogen isotope values in PACO and KAFL ( $12.9 \pm 0.9$  and  $12.2 \pm 0.3$  respectively) suggest that these fish were feeding at a higher trophic level than the ATMA, ARFL, WAPO ( $10.5 \pm 0.4$ ,  $11.5 \pm 0.5$  and  $10.5 \pm 0.8$  respectively) which could explain the slightly higher mercury levels in these two species.

*Bering Sea - Fish and Fish Habitat*

**Climate Change Impacts On Predator-Prey Dynamics In The Bering Sea: Changes To Foraging Rate And Species Preference Of Walleye Pollock, Pacific Cod, And Arrowtooth Flounder.**

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Climate change has already affected marine species and attendant fisheries worldwide, with future projected changes over the next 100 years postulated to be largest for arctic and sub-arctic ecosystems. Trophodynamic processes are likely to be directly affected, as changes in water temperature may increase metabolic costs and shift the spatial distribution of top consumers while environmental changes will alter primary and secondary production. Using historic climate and diet data in combination with down-scaled IPCC projections for the Bering Sea, we find evidence for complex shifts in spring and fall zooplankton production, consumer demand, and species diet preference under climate change that may intensify density dependent mechanisms (i.e., cannibalism) for pollock and shift spatial overlap of arrowtooth flounder and their primary prey species.

*Bering Sea - Fish and Fish Habitat***Patterns In Species Dynamics And Interactions In The Northeast Pacific**

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Abundance and distribution of marine species vary across time and space, reflecting biological interactions, environmental forcing, and external perturbation. Understanding the relative influence of these various drivers requires integrating community ecology with ecosystem approaches that consider habitat, environmental gradients, climate variability and change. We use time series of population dynamics and environmental conditions in Northeast Pacific systems (eastern Bering Sea, Gulf of Alaska, Aleutian Islands, and California Current) to explore physical-biological linkages underlying ecosystem structure and function and the mechanisms driving stability and change over time. We use detailed diet data to classify species to functional guilds and explore the extent to which species within and between guilds exhibit resource partitioning, spatial overlap, and competitive exclusion. Patterns suggest that habitat constraints and predator avoidance influence guilds in distinct ways such that, as abundances wax and wane, certain species expand and contract their range whereas others remain within a constant area and fluctuate in density. We apply random forest techniques to evaluate the relative influence of various environmental variables and quantify environmental thresholds for individual species. We then integrate outputs across species to explore how environmental gradients define distinct biological communities. Using dynamic factor analysis, we distinguish a set of common underlying trends in the dynamics of species within guilds and explore processes, comparing trends to large-scale environmental forcing. We also apply autoregressive multispecies models to quantify and distinguish the relative effects of density dependence, inter-species compensation, and environmental forcing. We note clear distinctions in physical and biological structure across systems but common trends in the dynamics of certain individual species across systems, suggesting either meta-population structure or evidence for synchrony through common external forcing. At the level of functional guilds, we note synchronous patterns and the absence of density dependence among species in guilds that exhibit resource partitioning. In contrast, we note evidence of compensatory dynamics among species in guilds characterized by extensive spatial overlap. These results provide insights as to the relative role of external drivers and inter-specific interactions in orchestrating ecosystem stability and change in these systems.

*Bering Sea - Fish and Fish Habitat*

**Seasonal Distribution And Relative Abundance Of Steller Sea Lion Groundfish Prey In The Aleutian Islands**

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In 1997, the western stock of the Steller sea lion population was declared endangered. One of the hypotheses for this decline was competition between the commercial groundfish fishery and Steller sea lions for prey. Groundfish stocks in Alaska are managed at large scales, however important ecological interactions, such as predation, spawning and habitat selection occur on local scales. Furthermore, commercial fishing is an activity with potential for localized effects. Improved understanding of the local abundance of fish is critical to understanding the potential for localized depletion by fishing. In order to understand the effects of fishing on a local scale, we need to assess abundance and distribution of the prey fields in local areas. This study assesses the local abundance and main prey item of Steller sea lions in the eastern and Central Aleutian Islands, Atka mackerel. The National Marine Fisheries Service conducted a tag release and recovery study at Seguam Pass, Tanaga Pass and Petrel bank. Approximately 27,000 tags were released and over 1,100 tags were recovered during 2011 and 2012. To date 99% of all recovered tagged fish stayed within 20 nm of their release locations. A integrated tagging model was used to estimate local abundance and small scale movement. Biological parameters of each population as well as physical oceanographic data were compared between the different locations. The results of this study contribute to an improved understanding of the small scale Steller sea lion prey field of Atka mackerel and their interactions with the commercial fishery.

*Bering Sea - Fish and Fish Habitat*

**Quantifying Habitat Impacts Of Raised Groundgear For The Bering Sea Pollock Fishery**

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In the US, federally managed fisheries need to minimize both by-catch and the adverse impacts of fishing on Essential Fish Habitat while maintaining commercially viable catch efficiency of target species. Like many other large scale commercial fisheries, the Alaska pollock fishery operations are increasingly constrained by efforts to avoid bycatch (salmon, crab and halibut) and the rising cost of fuel. Under the NPRB-funded project (# 1319), a research team including scientists from NOAA Alaska Fisheries Science Center and Alaska Pacific University, both major sectors of the Alaska pollock fishing industry, and members of the fishing gear design and fabrication industry is working programmatically to develop more optimal trawls for capturing pollock near the seafloor. This project addresses the seabed contact and benthic habitat impact aspects of several new groundgear configurations. Thus far raised groundgear (sweeps and footrope lifted off the seafloor by widely spaced bobbins) have resulted in reduced direct seafloor contact (Rose et al. 2010), reduced crab mortality (Rose et al. 2013, Hammond et al. 2013) and flatfish bycatch, while maintaining pollock fishing performance relative to standard ground gear. During summer 2014 we will systematically vary bobbin weight, spacing and seafloor clearance to: 1) quantify the component-specific (e.g. sweep, bobbin, footrope) seabed contact; 2) determine susceptibility of structure-forming geological and biological seabed features to these new groundgear; and 3) compare the contact-adjusted swept areas of, and habitat-feature susceptibilities to, each configuration to support a quantitative evaluation of the new pollock trawl designs within the context of a fishery habitat impacts assessment. This work directly addresses bycatch and essential fish habitat concerns of the North Pacific Fisheries Management Council.

*Bering Sea - Fish and Fish Habitat***Inshore And Offshore Habitat Use By Age-0 Pacific Cod In The Southeastern Bering Sea**

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The Bering Sea nursery habitats of several commercially important fishes remain unknown. In particular, the Bering Sea offers relatively little of the shallow, subtidal waters in coastal embayments that are the primary nursery habitats of juvenile Pacific cod through much of their range. In this study we examined the importance of coastal demersal habitats in the Bering Sea for age-0 Pacific cod. Beam trawling was conducted at depths of 20 - 140 m in four years on the southeastern Bering Sea shelf and along the Alaska Peninsula (AKP). Age-0 fish were more abundant along the Alaska Peninsula to depths to 50 m than they were in deeper waters along the AKP or farther north on the shelf. In addition, one year of spatially intensive sampling at depths of 5 – 30 m was conducted in a nearshore focal area along the central AKP. In this survey, age-0 Pacific cod were more abundant along the open coastline than they were in the coastal embayments of Port Moller and Herendeen Bay, counter to patterns observed in the Gulf of Alaska. As observed in earlier studies, age-0 Pacific cod were also captured in pelagic waters over the middle and outer shelf, with maximum catches occurring over depths of 60-80 m. Spatial- and size-distribution patterns suggest that habitat use in the Bering Sea occurs along a gradient from coastal to pelagic. Although a regular component of the habitat portfolio of age-0 Pacific cod, surface waters over the shelf may represent only a minor part of cumulative cohort. While capture efficiencies may differ among trawl types, CPUE of age-0 cod in coastal waters along the AKP was 25-100 times those observed in surface waters over the shelf. Despite representing much smaller habitat area, the cumulative contribution of coastal waters along the Alaska Peninsula appears to be markedly larger than those of the offshore surface and demersal shelf habitats combined.

*Bering Sea - Fish and Fish Habitat***Effects Of Ocean Acidification On Tanner Crab, *Chionoecetes Bairdi*, Larvae**

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Anthropogenic burning of fossil fuels is causing an increase in the carbon dioxide concentration in both the atmosphere and oceans. This has caused the pH of the oceans to drop about 0.1 pH units since the start of the industrial revolution and a further decrease of 0.3 units is likely by the end of the century. This change in pH, or ocean acidification, is expected to affect marine animals and communities with calcifying species expected to be particularly vulnerable. We tested the effects of decreasing pH on embryogenesis and fecundity in Tanner crab, *Chionoecetes bairdi*. Ovigerous Tanner crabs with newly extruded embryos were captured in the Gulf of Alaska and held at ambient (8.0), 7.8, and 7.5 pH waters throughout embryo development. Embryos were sampled monthly and measured using digital micrographs. Hatch timing and fecundity were determined by quantifying larval output throughout larval release. After hatching, females were allowed to mate and extrude a second clutch of embryos and the experiment was repeated for a second year. Embryo size at the end of the first year was slightly higher with decreasing pH. At the end of the second year, most of the embryos that developed in pH 7.5 waters failed to hatch, resulting in a decrease in fecundity. Hatching failure was also observed in the other treatments to a lesser degree. Results indicate that at a lower pH there is an increase in hatching failure, however hatching failure among all the treatments lends this result inconclusive. Overall project results suggest that ocean acidification may have a negative impact on the Tanner crab population.

*Bering Sea - Fish and Fish Habitat***Developing Maturity Schedules For Data-Poor Commercially Important Flatfishes**

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Developing maturity schedules for data-poor commercially important flatfishes in the eastern Bering Sea and Aleutian Islands Todd TenBrink and Tom Wilderbuer Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, Seattle WA

Maturity ogives (the proportion of a population mature by age) are an important metric of fish populations, and play a critical role in the formulation of fishing reference points and harvest specifications. In an effort to substantially update maturity inputs to age-structured stock assessment models for commercially important flatfishes within the Bering Sea-Aleutian Islands (BSAI) management area, several species were targeted to obtain and/or update maturity information. In order to meet this objective, ovary and otolith (age structure) samples were collected from pre-spawning and spawning females for subsequent histological analysis and ageing. The maturity estimates generated from this study will be incorporated into current stock assessment models to provide updated spawning stock biomass (SSB) estimates and biological reference points. Yellowfin sole (*Limanda aspera*) samples were collected during the summer of 2012 aboard vessels participating in the annual AFSC groundfish survey of the eastern Bering Sea. Age and length at 50% maturity for yellowfin sole were estimated at 9.9 years at 29.1 cm. The age at maturity estimate represents a slight decrease from the 1992-1993 estimate that is currently used in the stock assessment model (10.5 years). Alaska plaice *Pleuronectes quadrituberculatus* and flathead sole *Hippoglossoides elassodon* were collected during commercial fishing operations during late winter and early spring of 2012 and 2013. These updated maturity estimates for Alaska plaice will replace prior estimates derived from a less reliable method of visual observations in the field from the 1980s. Our age at 50% maturity estimates for this species using histology was 9.0 yrs. Updated maturity estimates for flathead sole will be forthcoming after ageing has been completed. Our objective to collect samples necessary for developing maturity schedules for the proposed deep-water flatfish species (arrowtooth flounder, Kamchatka flounder, and Greenland turbot) were not successful, but general notes on their reproductive biology have been documented similar to the other species.



*Bering Sea - Humans***Fish Skimmer, A Novel Design For Reducing The Effects Of Trawl Footropes On Crabs**

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To operate effectively, bottom trawls must maximize capture of the targeted fish, while avoiding capture or damage to untargeted species and damage to the net by obstructions on the seafloor. Trawl footropes, the leading edge of a bottom trawl, are designed to balance these goals. Conventional footropes consist of a line passed through the centers of a series of round devices (e.g., bobbins, rollers, disks). Larger diameter devices are usually used to protect the net, when used on rough seafloors, or to prevent capture of animals on the seafloor that are not prone to upward swimming (e.g., crabs). In Bering Sea groundfish fisheries, avoiding crab mortality is a high priority. Mortality can occur to captured crabs (bycatch) or those that pass under footropes. Damage to crabs passing under footropes occurs mainly upon hitting components that directly contact the seafloor. While wider contact spacing and higher clearance of sections in between will reduce such damage, it can also allow escape of targeted fish. We tested a device designed to be inserted in spaces under the footrope to inhibit escape of target species while minimizing damage to crabs. A trawl footrope was equipped with a minimal number of conventional bobbins, with Fish Skimmers filling the spaces between bobbins. Fish Skimmers are light rubber devices appendages toggled into the spacing between footrope bobbins that orient into the flow and tilt aside with very little pressure/force when encountering hard objects. Fish capture was comparable to a conventional footrope and mortality of crabs passing beneath was lower than any previously tested footrope. However, the footrope did catch a higher proportion of crabs than conventional gear. Attempting to improve fish capture, Fish Skimmers were equipped with lights. The only species for which lights changed catch rates actually escaped more with lights on the footrope. This experimental footrope showed good potential to reduce damage to crabs and other seafloor features and inhabitants, but will need further research to understand and mitigate the problem of increased crab capture.

*Bering Sea - Humans***Spilled Oils: Static Mixtures Or Dynamic Weathering And Bioavailability?**

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Polynuclear aromatic hydrocarbons (PAHs) from sequestered Selendang Ayu (S. Ayu) oil were biologically available 3.6 y after it was spilled along Unalaska Island, Alaska. Thermodynamically driven weathering was the most probable mechanism of exposure. Alkane and PAH composition in oil changed over time as smaller constituents were preferentially lost, indicative of weathering. In contrast, composition of the largest compounds (biomarkers) including triterpanes, hopanes, and steranes remained unchanged. Smaller molecules (the PAHs) lost from stranded S. Ayu oil were observed in indigenous mussels and passive samplers deployed in July 2008. Concentration and composition of PAH were significantly different than in the reference area and patterns observed in mussels were repeated in passive samplers deployed in three zones (intertidal, subtidal, and water). Thus, hydrocarbons lost from one compartment (sequestered whole oil) were detectable in another (mussels and passive samplers) implying aqueous transfer. Quantities of mobile oil constituents were small, yielding uptake concentrations that are likely inconsequential for mussels, but the sensitivity provided by bioaccumulation and passive sampler uptake ensured that dissolved hydrocarbons were detectable.

*Bering Sea - Humans*

**We Depend On The Sea: The Importance Of Walrus To Little Diomed**

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Diomed people maintain a long-standing and complex relationship with walrus. Every part of the walrus has its own specific use so that no part is wasted – the meat provides nourishment, the stomach made into drums, the hide used to make boats, and the tusks made into harpoon tips and jewelry, just to name a few of the many uses Diomed people have for walrus. As a result, great cultural value and meaning are attached to walrus, as individuals have relied heavily on the harvest of walrus to sustain them since time immemorial. Although this relationship between Diomed people and walrus has changed over time, walrus remain a critical resource for people on Little Diomed today. This poster presentation illustrates some of the final products of a traditional knowledge project carried out by Kawerak, Inc. and the Native Village of Diomed.

*Bering Sea - Humans*

**Fishset: A Tool To Better Incorporate Fisher Behavior Into Alaska Fisheries Management**

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Since the 1980s, fisheries economists have modeled the factors that influence fishers' choices of when and where to fish and to understand the trade-offs of fishing in different locations. This knowledge can improve predictions of how fishers will respond to the creation of spatial closures such as those in place to protect Steller sea lions (SSL), to changes in market conditions, or to management actions such as the implementation of catch share programs. NOAA Fisheries and partners are developing the Spatial Economics Toolbox for Fisheries (FishSET). The aim of FishSET is to join the best scientific data and tools to evaluate the trade-offs that are central to fisheries management. FishSET will improve the information available for NOAA Fisheries' core initiatives such as coastal and marine spatial planning and integrated ecosystem assessments and allow research from this well-developed field of fisheries economics to be incorporated directly into the fisheries management process. Importantly, the toolbox brings together the best available models and data so that analyses can be conducted at the time that policies are being evaluated. In this talk, we provide an overview of the modeling approach, details of project implementation, and a preview of the FishSET software. An initial step of the project is the development of best practices and tools to improve data organization. A second core component is the development of estimation routines that enable comparisons of state-of-the-art fisher location choice models. FishSET will enable new models to be more easily and robustly tested and applied when the advances lead to improved predictions of fisher behavior. FishSET efficiently organizes statistical code so that leading innovators can build on each other's work and methods can be widely available to economists and managers. Pilot projects that utilize FishSET are under development in different Regions including Alaska, which will ensure that the data challenges that confront modelers are confronted at the onset of the project. We discuss a variety of ways in which FishSET can be utilized in Alaska fisheries management.

*Bering Sea - Humans***Modeling Biological And Economic Implications Of Layered Management Measures For Bering Sea Groundfish Fisheries**

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Fisheries management regulations in the Bering Sea have been incrementally developed over time in response to changes in legislation, resource conditions, catches, industry structure, scientific information and many other factors. Each new layer of regulation has been added to achieve a specific objective—without necessarily considering the incremental effects on the overall objectives of the management system. Furthermore, existing regulations have not typically been redesigned to minimize their adverse effects when interacting with newly added layers of regulations. The result is an increasingly complex and rigid system of layered management that restricts the adaptive capabilities of fishermen that are necessary for achieving both economically and ecologically sustainable exploitation. The purpose of our study is to evaluate the complex suite of regulations that govern Bering Sea groundfish fisheries and examine whether a simpler set of better-coordinated regulations might result in higher sustainable harvests or lower harvesting costs, with no appreciable effects on ecosystem composition and functioning. To accomplish this task, we are developing a state-of-the-art bioeconomic model based on spatial and temporal fishing opportunities, ecological conditions and regulatory constraints. We will use our multi-fishery simulation model to evaluate what the biological and economic outcomes would have been in recent years, had the system of regulations been different. Using prevailing stock conditions and fishing pressure predictions from our model, we will compare the stock and economic outcomes in different Bering Sea fisheries under alternative combinations of regulations in order to identify those regulations that allow increased fishery benefits and meet ecosystem goals. Our presentation will focus on describing the implications of a rigid management system and the importance of facilitating adaptive fishing behavior for attaining economically and biologically sustainable fisheries. In addition, we will present the overall framework of our model—along with some preliminary results—with a particular focus on the methods used to integrate the spatial and temporal dimensions of a multispecies ecosystem with the behavioral flexibilities of Bering Sea groundfish harvesters.

*Bering Sea - Lower Trophic Levels***The Spring Fate Of Ice Algae In The Bering Sea**

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Sea ice algae play a key role in Arctic marine ecosystems, contributing a significant amount to primary production in early spring. During ice melt, ice algae are released into the water column where they may be consumed by pelagic grazers or sink to the benthos. Ice algae may also remain viable in the water and contribute to the ice-edge phytoplankton by seeding the spring bloom. Ice algal seeding has been observed in several polar regions, but much of the evidence is circumstantial. In the Bering Sea, the timing of the ice-edge bloom corresponds with the release of ice algae and modeling studies support ice algal seeding, but no data exist on which algal species may be contributing to this effect. Differential seeding among ice algae could have tremendous impacts on future phytoplankton blooms as climate change alters the composition of the ice algal communities that are released into the water. This project aims to determine the species-specific fate of ice algae using ice, water, and sub-ice sediment trap samples from across the Bering Sea shelf. Comparisons between these samples will show the ice algal species may be contributing to the ice-edge bloom as well as those that are primarily exported to the benthos. This project will establish the abundance and diversity within ice algal communities in the Bering Sea and determine how the fate of ice algae changes between periods of spring ice growth and ice melt. The results of this study will provide the first ever full assessment of ice algal diversity in the Bering Sea, and yield information that is crucial for predicting the impacts of a changing sea ice regime on the Bering Sea system.

*Bering Sea - Lower Trophic Levels***Red King Crab Movement, Growth, And Size Composition In Eastern Norton Sound, AK - Year 2**

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In 2012 and 2013 red king crab *Paralithodes camtschaticus* were tagged and released in the spring and recovered during the summer commercial fishery. In 2013, a total of 9,079 red king crab were tagged, almost double the number tagged in 2012. The size composition of tagged crab between the two years differed greatly. In 2012, 60% of tagged crab were legal males but only 36% of tagged crab were legal males in 2013. The change in catch composition within the tagging pots was primarily due to an increase in pre-recruit 3 (74–83 mm CL) crab which made up 29% of the catch in 2013 and only 10% in 2012. In 2013, during 74 days of commercial fishing, 5 observers made 54 trips, recovered 77 tagged crab, and examined 210 pots for species composition. In 2012, 3 observers made 31 trips, recovered 60 tagged crab, and examined 106 pots for species composition during the 44 day commercial fishery. In both years red king crab (all sizes) was the most abundant species in the majority of commercial fishery pots followed by purple orange sea stars *Asterias amurensis*. Movement patterns of tagged crab were generally consistent between years. Red king crab were at liberty in both years for approximately 35 days on average and moved an average of 39 km in 2013 and 40 km in 2012. The average speed of crab was similar in 2012 (1.2 km/day) and 2013 (1.5 km/day) however, one crab attained speeds of 16.5 km/day in 2013 while the fastest crab in 2012 had a speed of 3.20 km/day. Finally, linear directional movement was similar in 2012 and 2013 and tended to be offshore to the southwest.

*Bering Sea - Lower Trophic Levels***Carbon Sources In Bering Sea Zooplankton: Insights From Fatty Acids And Their Carbon Stable Isotopes**

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Fatty acids (FAs) and carbon stable isotope composition of individual FAs ( $\delta^{13}\text{CFA}$ ) were used to infer foraging patterns and identify potential sources of carbon to zooplankton during maximum ice extent, ice melt, and ice-free conditions in the Bering Sea in 2009 and 2010. FA profiles differed between *Themisto libellula*, *Calanus marshallae/glacialis*, and *Thysanoessa raschii*, implying different foraging strategies. Within species, there was little seasonal and annual variation in FA profiles. The bacterial FA biomarker (sum of 15:0, 17:0, iso- and anteiso-branched chain FA) indicated little contribution of bacterial FA in all three species (<2.5%). The amount of the diatom FA biomarker (sum of 16:1n-7, C16 polyunsaturated FA, and 20:5n-3) suggested that diatoms were more prominent in *T. raschii* and *C. marshallae/glacialis* (21–37% and 21–42%, respectively) than *T. libellula* (17–27%). Levels of the flagellate FA biomarker (sum of C18 and C22 polyunsaturated FA) ranged between 15–26%, 11–19%, and 6–23% in *T. libellula*, *C. marshallae/glacialis*, and *T. raschii*, respectively. The amount of the *Calanus* copepod FA biomarker (C20 and C22 monounsaturated FA) in the predatory *T. libellula* (8–13%) indicated the presence of *Calanus* copepods in their diets. We ran four carbon stable isotope mixing models using several combinations of the  $\delta^{13}\text{CFA}$  of 16:1n-7, 20:5n-3, and 22:6n-3 quantified in sea ice and pelagic particulate organic matter as sources of carbon to estimate the proportional contribution of sea ice derived carbon in zooplankton. Model estimates ranged between 36–72%, 27–63%, and 39–71% of sea ice derived carbon to *T. libellula*, *C. marshallae/glacialis*, and *T. raschii*, respectively. Regardless of differences in foraging patterns, our results suggest that these three species of zooplankton are linked to sympagic sources of FA. Zooplankton serve as a key trophic link in the transfer of nutrients such as FAs from phytoplankton to upper trophic levels in the marine food web. Changes in the timing of sea ice retreat, predicted loss of sea ice and sea ice primary productivity will lead to a reduction in sympagic FA available to zooplankton and may alter food web dynamics in the Bering Sea.



*Bering Sea - Lower Trophic Levels***Storage And Utilization Of Lipid Classes And Fatty Acids During The Early Ontogeny Of Blue King Crab, *Paralithodes Platypus***

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Stock enhancement, through the release of cultured juveniles, has been suggested as a possible recovery tool for depleted red (*Paralithodes camtschaticus*) and blue (*P. platypus*) king crab populations in Alaska, USA. Considerable progress has been made in the past decade in red king crab culture technology, but similar technologies are less developed for blue king crabs. We examined changes in organic content, lipid classes, and fatty acids (FAs) during the larval (*zoeae*), post-larval (*glaucothoe*), and first juvenile stages to understand energetics, nutritional requirements, and potential dietary deficiencies of this new aquaculture species. Total lipids increased throughout the larval stages and then showed a decrease in both total lipids and neutral storage lipids (triacylglycerols) during the *glaucothoe* phase. The proportions of C18 polyunsaturated FAs (PUFA) dramatically increased from the first zoeal (Z1) to the second zoeal stage (Z2), reflecting the uptake of enriched *Artemia* FAs. Both the selective retention of C20 & 22 PUFAs relative to their diet and the proportional increase in these PUFAs during the non-feeding *glaucothoe* stage suggests that they are essential for early growth and survival. Analytical measures of total lipids were highly correlated with a hatchery-based visual assessment of maximum lipid droplet size, an index of relative nutritional health. Formulated hatchery larval diets containing high levels of C20 & 22 PUFAs may optimize nutrition in early ontogeny for blue king crabs, but future research should refine specific ratios and absolute amounts.

*Bering Sea - Mammals***Where's Walrus? Image Analysis Tools To Assist Identification Of Walrus In Digital Aerial Photography And Analyze Surrounding Sea Ice Habitat**

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The Pacific Walrus is currently being considered for listing as threatened under the Endangered Species Act due to recent and predicted loss of habitat caused by Arctic sea ice retreat. However, walrus use only a small fraction of the total area of ocean covered by sea ice and so the relationship between sea ice retreat and habitat loss is not well quantified. Using a subset of NOAA's Loss of Sea Ice (LOSI) aerial imagery from 2012 in the Bering Sea shelf, we developed a 3-band multispectral filter to identify pixels corresponding to the skin tones of walrus. The filter identified walrus-colored pixels in 825 images, of which 51 were found to contain walrus upon manual inspection which represents over a 99% reduction in the number of images requiring manual inspection. Moreover, many of the scenes that did not contain walrus exhibited other information pertinent to population assessments such as blood and scat. More than 260 walrus were found with a mean of 5 walrus per aerial scene, with one scene including approximately 62 individuals. We also computed floe properties of sea ice from scenes occupied by walrus and compare them with those of unoccupied sea ice. Here, we present the results from the spectral filter, along with a comparison of floe-size statistics for images of occupied and unoccupied sea ice. In occupied images, mean floe area was 18 m<sup>2</sup> (2-477 m<sup>2</sup> range), while mean perimeter was 24 m (5-308 m range). By comparison, mean unoccupied floe area measured 30 m<sup>2</sup>, while mean perimeter measured 30 m (7-334 m range). Floes that were not fully contained in-image were excluded from this analysis. Improving filter detection to include walrus scat, sediment, and blood identification, as well as increasing more usable data could yield better parameters for walrus floe preferences. With further development, we hope these tools will assist with data analysis for both past and future marine mammal observations. Using these tools and analyses of walrus ice floe preferences, we hope to begin the first step towards a better understanding and basis for seascape scale Pacific Walrus habitat.

*Bering Sea - Mammals*

**Brucella Placentitis And Seroprevalence In Northern Fur Seals (*Callorhinus Ursinus*) At St. Paul Island, Alaska**

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Infection of marine mammals with *Brucella* sp. has raised concerns from both the animal and human health fields. The northern fur seal (NFS, *Callorhinus ursinus*) has experienced significant population declines since the late 1950's and there has been increasing effort to investigate potential causes of the decline, including infectious disease. The objective of this study was to determine if NFS have serologic or placental evidence of *Brucella* exposure or infection. Archived serum (25 sub-adult males, 11 adult females, 4 female pups) and placentas (n=119) collected on St. Paul Island, Alaska, were available for use in this study. Serum was tested for *Brucella* by IS711 PCR and *Brucella* microagglutination test (BMAT). A single sample was positive by PCR, another was positive on BMAT while 12 additional samples had borderline BMAT titers. Six (5%) of the 2011 placentas were positive by PCR. Six sections from each of the PCR positive placentas were available for histologic examination. In a single section of one placenta there was a regionally extensive area of necrosis and inflammation resulting in substantial tissue loss and *Brucella* was detected within the lesion by immunohistochemistry. No organism was identified in the other placentas that were positive by PCR, however four of the five had small foci of necrosis or suppurative inflammation in at least one of the examined sections, and a single placenta had foci of mineralization that appeared slightly increased relative to previously reviewed placentas from this species. Overall, it appears that exposure to *Brucella* is not uncommon within this NFS population, and this infection can cause histologic, and sometimes severe, changes within the NFS placenta. The relationship of these findings to the observed population trends is unclear.

*Bering Sea - Mammals*

**Freshwater Seals Of Iliamna Lake: Where Are They When The Lake Is Frozen?**

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Iliamna Lake is home to a group of “freshwater” harbor seals which likely spend the entire year in this large lake located approximately 225 miles northwest of Anchorage. Although the seals have access to Bristol Bay via the 75+ mile long Kvichak River, it remains unclear whether all or some proportion of the seals remain in the lake when it is iced-over. Aerial surveys in early April have documented as many as 73 seals hauled out on the ice, but in some years, no seals were found. There are approximately 250-300 seals in the lake, at a minimum, during the August molt, so where are all these seals in winter and early spring? Understanding if this group of seals are permanent year-round residents in the lake or some portion migrate in and out from/to Bristol Bay is necessary to determine if there may be more than 1 group (stock?) of seals. Local Traditional Knowledge on this topic varies, by village, and are not in complete agreement with one another. We interviewed many native elders and hunters and asked where are all the seals when the lake and surrounding rivers are frozen-over. To our surprise, they consistently told us that seals are under the ice in air pockets left when the lake water level lowered after the ice sheet/cover has formed. Some elders told us they often hear seals under the ice when they walk above them. We have since found similar evidence elsewhere of this phenomenon i.e. large air pockets, likely large enough for many seals to completely haul out above water, but below the ice sheet covering the lake. These seals would not be visible from the air during our surveys. This could help explain why our counts of seals are so variable and significantly lower than the number presumed to be present in the lake during late winter and early spring. We have plans to place satellite tags on these seals in the near future to help answer these and other related questions.

*Bering Sea - Mammals***2011 Fukushima Fall Out: Aerial Deposition On To Sea Ice Scenario And Wildlife Health Implications To Ice-Associated Seals**

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On March 11, 2011 off Japan's west coast, an earthquake-generated tsunami struck the Fukushima Daiichi nuclear power plant resulting in a major nuclear accident that included a large release of airborne radionuclides into the environment. Within five days of the accident atmospheric air masses carrying Fukushima radiation were transiting into the northern Bering and Chukchi seas. During summer 2011 it became evident to coastal communities and wildlife management agencies that there was a novel disease outbreak occurring in several species of Arctic ice-associated seals. Gross symptoms associated with the disease included lethargy, no new hair growth, and skin lesions, with the majority of the outbreak reports occurring between the Nome and Barrow region. NOAA and USFWS declared an Alaska Northern Pinnipeds Usual Mortality Event (UME) in late winter of 2011. The ongoing Alaska 2011 Northern Pinnipeds UME investigation continues to explore a mix of potential etiologies (infectious, endocrine, toxins, nutritious etc.), including radioactivity. Currently, the underlying etiology remains undetermined. We present results on gamma analysis (cesium 134 and 137) of muscle tissue from control and diseased seals, and discuss wildlife health implications from different possible routes of exposure to Fukushima fallout to ice seals. Since the Fukushima fallout period occurred during the annual sea ice cover period from Nome to Barrow, a sea ice based fallout scenario in addition to a marine food web based one is of particular relevance for the Fukushima accident. Under a proposed sea ice fallout deposition scenario, radionuclides would have been settled onto sea ice. Sea ice and snow would have acted as a temporary refuge for deposited radionuclides; thus radionuclides would have only become available for migration during the melting season and would not have entered the regional food web in any appreciable manner until breakup (pulsed release). The cumulative on-ice exposure for ice seals would have occurred through external, inhalation, and non-equilibrium dietary pathways during the ice-based seasonal spring haulout period for molting/pupping/breeding activities. Additionally, ice seals would have been under dietary/metabolic constraints and experiencing hormonal changes associated with reproduction and molting.

*Bering Sea - Mammals***Uncinaria Lucasi And Uncinariosis: Monitoring Studies Of Northern Fur Seals (*Callorhinus Ursinus*) On St. Paul Island, Alaska**

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From the first report in 1896 (Lucas, 1899), the hookworm (*Uncinaria lucasi*) was recognized as one of the main causes of death of northern fur seal (NFS) (*Callorhinus ursinus*) pups on the Pribilof islands, Alaska. Prevalence of *U. lucasi* in NFS pups was 100% on some rookeries till the end of 1960s, and pup death from uncinariosis was very high. Later, dramatic declining of NFS populations at the Pribilof islands – from 300–400,000 in the 1950–60s to about 120,000 in the early 2000s, caused dramatic decreasing of *U. lucasi* prevalence and intensity in NFS pups there – from 90% in 1970s to 3–6% in 2007–2011. Three-year monitoring studies were performed at St. Paul Island, Alaska, to analyze occurrence and intensity of NFS infection of *U. lucasi* at several rookeries. In July–August 2011–2013, 104 dead NFS pups were collected mainly from Reef (rocky rookery), a few from Vostochny, Morjovj and Zapadny (sandy rookeries). Blubber samples (150 g each) were collected from 293 sub-adult NFS males (SAMs) humanely harvested during annual Aleut subsistent harvests. *U. lucasi* larvae were extracted from blubber samples by the Baermann funnel system, and identified under a compound microscope. Prevalence of *U. lucasi* in pups from Reef rookery varied at three years – 4.9% in 2011, 0% in 2012 and 10.5% in 2013. Prevalence in pups on Vostochny and Morjovj rookeries (2012) were 50% and 75%, respectively, and 0% in Zapadny rookery (2013). Intensity of pup infection was from 1 to 154 hookworms. Blubber examination of SAMs has revealed prevalence of infection by *U. lucasi* parasitic third stage larvae from 3% (in 2011) to 2.5% (in 2013) with intensity from 1 to 11 larvae. Results obtained during these three-years studies showed that despite rather low prevalence and intensity of *U. lucasi* in pups at some rookeries on St. Paul Island, this parasite still has to be considered as a possible factor causing death of NFS pups. Further monitoring studies of *U. lucasi* on different types of rookeries are necessary to estimate potential epidemiological risk of uncinariosis in the NFS population on the Pribilof islands and in the Bering Sea.

*Bering Sea - Mammals***Serologic Survey For Exposure To Marine And Terrestrial Pathogens In Seals Of The Bering And Chukchi Seas**

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Little is known about the health of and exposure to diseases in ice-associated seals of the Bering and Chukchi Seas, which include ribbon (*Histiophoca fasciata*), spotted (*Phoca largha*), and bearded seals (*Erignathus barbatus*). A warming climate and diminished sea ice could have significant effects on the health of ice-associated seals; therefore, collecting baseline data on health parameters and exposure to disease may provide the ability to detect future climate-related changes in health. To assess exposure to several common marine and terrestrial pathogens, ribbon and spotted seals were sampled at the edge of the pack ice of the Bering Sea during spring of 2007-2010, and bearded seals were sampled in the pack ice in Kotzebue Sound, Alaska during summer 2009, 2011, and 2012. Serologic tests were conducted to test for antibodies against phocine herpesvirus-1 (PhHV-1), *Leptospira interrogans*, *Toxoplasma gondii*, *Sarcocystis neurona*, influenza A, *Brucella* spp., and *Coxiella burnetii*. Spotted seals were positive for antibodies to PhHV-1 (76.6%), influenza A (10.6%), *Brucella* spp. (8.5%), and *Coxiella burnetii* (8.3%), while ribbon seals tested seropositive for PhHV-1 (9.5%), influenza A (4.8%), and *Coxiella burnetii* (8.0%), and bearded seals only tested seropositive for PhHV-1 (33.3%). All species were seronegative for antibodies to *Leptospira interrogans*, *Toxoplasma gondii*, and *Sarcocystis neurona*. Overall, antibody prevalences in these ice seals were fairly low for most pathogens, with the exception of the high proportion of spotted seals that were seropositive to PhHV-1. This indicated that the populations have had low-level exposure to a variety of diseases, but currently none seem to be widespread.

*Bering Sea - Mammals***Measuring Food Intake And Energy Expenditure Of Northern Fur Seals During Lactation: Can Energy Proxies Predict Mass Change?**

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Divergent abundance trends among Northern fur seal *Callorhinus ursinus* populations in recent years have been difficult to explain. For example fur seal numbers on the Pribilof Islands have been in decline while numbers have increased at other sites such as Bogoslof Island in the Aleutian Islands and in the Kuril Islands in Russia. The potential influence of food limitations could be studied by examining the energy budgets of individual lactating fur seals. Our goal was to find suitable proxies for food intake and energy expenditure of lactating seals so that we might provide time and energy budgets of an increasing population on Lovushki Island, Russia that could be compared with the declining Pribilof fur seal population. Between 2005–2008, we outfitted 13 lactating fur seals with instruments that provided data on depth, external temperature, stomach temperature, GPS location, and acceleration. With these data we investigated proxies for 1) food intake, including time spent at sea, time spent diving, vertical travel distance (VTD), wiggle behavior, and changes in stomach temperature; 2) involuntary costs, including indices of basal metabolism (BMCI), thermal exposure, and instrument hydrodynamic drag (TAG); and 3) locomotive costs, including overall dynamic body acceleration (ODBA), horizontal travel distance, and flipper strokes. We also considered an index of work (WORK) calculated using horizontal distance, ODBA, and seal mass. Multimodel inference was used to determine which proxies best described changes in seal mass at sea when considering two sets of candidate models that differed by excluding or including locomotive costs ( $n = 13$  and  $n = 7$ , respectively). We found that mass changes were positively related to both VTD and TAG and negatively associated with BMCI ( $p < 0.001$ , adjusted  $R^2 = 0.84$ ) with locomotive proxies excluded, and were positively related to VTD and negatively associated with WORK ( $p < 0.001$ , adjusted- $R^2 = 0.95$ ) with locomotive proxies included. This study demonstrates that the energy budget of individual lactating northern fur seals can be examined using proxies for energetics that are easily monitored with standard datalogging tags. These methods could be applied to study how food limitations may be differentially impacting northern fur seal populations across the species' range.



*Bering Sea - Mammals***Steller Sea Lion Studies In The Northern And Eastern Bering Sea, Alaska**

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Steller sea lions (*Eumetopias jubatus*; SSL) were once abundant along the North Pacific Rim but have declined by more than 80% since the 1970s in the western Alaska portion of their range. Spatial and temporal distribution and abundance of SSLs have been poorly understood in the northern and eastern Bering Sea during the period of decline due to a paucity of data from this region. We compiled and analyzed older count data from Round Island and Cape Newenham, the two primary haulouts in Bristol Bay, and initiated surveys in the Bering Strait beginning in 2010. The number of sea lions counted at Round Island declined 2.6%/yr (95% CI -3.8% to -1.7%) from 1985-2007, and counts at Cape Newenham declined 9.8%/yr (95% CI -10.3% to -9.4%) from 1990-2005; we update these trends through 2012. In the Bering Strait, nearly 500 SSLs were counted in October and November 2012. Residents from the Bering Strait village of Gambell on St. Lawrence Island reported unusually large numbers of SSLs hauled out nearby, inspiring us to conduct brand-resight surveys to determine the origin of animals using this site. We found SSLs from five natal rookeries were represented, spanning the North Pacific Ocean from the western Aleutians in Russia to southern Alaska near the US-Canada border. Four males documented at or near their natal rookery during summer 2010 travelled to St. Lawrence Island in fall 2010, then returned to (or near) their natal rookery by the following summer; one such trip was a minimum round-trip distance of 6,000km. Sea temperature increases and sea ice declines likely will lead to increased activities in the northern Bering Sea such as oil and gas exploration and development, northward shifts in commercial fisheries, and increases in ship traffic. Understanding sea lion distribution and abundance will help resource managers evaluate and mitigate the impacts of these activities.

*Bering Sea - Mammals***Is There A Relationship Between Diet And Population Trend Of Steller Sea Lions In The Aleutian Islands?**

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Indices of Steller sea lion diet diversity in five Aleutian Islands regions were generally related to population trends since 2000, but overall were poorly correlated ( $r^2 = 0.39$ ;  $P = 0.26$ ). Sea lions in three regions west of Tanaga Pass had the three lowest diet diversity indices and declining population counts. Conversely, in two eastern regions between Tanaga and Samalga Passes, diet diversity was higher and trends were either stable or increasing. However, regions at opposite ends of the chain had similar diet diversity, yet counts declined sharply in the west (-7% y-1) but increased in the east (2% y-1). When all diet data collected since 1990 are considered (3,156 scats), diversity was greater in 2000-2012 than in 1990-1999, and greater in the non-breeding (September-April) than breeding (May-August) season. Overall, the top five species in the diet changed from Atka mackerel, salmon, squid, Pacific cod and pollock in the 1990s to Atka mackerel, Irish lords, rockfish, Pacific cod and smooth lumpsucker in the 2000s, with only Atka mackerel and Pacific cod appearing in both lists. Curiously, the top five breeding season prey from 1990-2012 matched the all-year 1990s list, while the top five non-breeding season prey matched the 2000s list. The frequency of occurrence of cephalopods was over three times greater in DNA than hard part analyses (39% v 11%), and more than double for Pacific cod (42% v 18%). Both DNA and hard parts identified smooth lumpsucker, Atka mackerel, and rockfish at similar levels. DNA identified notably fewer occurrences of Irish lords, greenlings besides Atka mackerel, and rock sole. These differences potentially reflect retention and regurgitation of cephalopod beaks and large fish bones, technical differences in prey identification success, and also that hard parts reflect a comparatively longer past dietary history. Species-specific breakdowns will be presented of cephalopod, salmon and rockfish species consumed as determined using DNA-DGGE-sequencing. In addition, we will analyze summer Aleutian bottom trawl survey data to determine if differences in diet diversity east and west of Tanaga Pass are related to differences in groundfish community structure, and to examine decadal differences in species prevalence (e.g., smooth lumpsucker).

*Bering Sea - Mammals*

**Acoustic Repertoire Of Breeding Captive Spotted Seals, 1977-1980: Reanalysis Of A Unique Data Set**

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Advances in signal processing have aided development of tools to identify and describe the vocal repertoire of mammals, particularly in the area of marine mammal research. We reanalyze tape recordings of two mating captive spotted seals, recorded by Dr. Douglas Wartzok in 1977 and 1980 to provide more detail on the temporal and spectral characteristics than was possible using previous methods. Two spotted seal pups were collected from the Northern Bering Sea in 1969 and brought to the John Hopkins University in Baltimore, Maryland, where they mated in 1977 and 1980. A detailed study was conducted of their behavior during mating, including recording their underwater vocalizations. Analyses of sonograms were the subject of the only publication on the acoustic behavior of the species (Wartzok 1979) and one subsequent master's thesis (Gailey-Phipps 1984). We reanalyzed these recordings using visual inspection of high resolution spectrograms and averaged spectra of calls. New spectrograms of call types are presented along with plotted spectra and descriptive statistics. These results will help with the recognition of spotted seal vocalizations in autonomous acoustic recordings collected throughout the range of the species. We also present possible call types that may not have been described in the original analyses.

*Bering Sea - Mammals***Baleen Whale Density And Distribution In Relation To Environmental Variables And Prey Abundance In The Eastern Bering Sea**

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The Bering Sea is one of the most productive marine ecosystems in the North Pacific and an important habitat for baleen whales. Because of its ecological and commercial importance and its sensitivity to climate change, the eastern Bering Sea (EBS) was the focus of a comprehensive study (The Bering Sea Project, BEST-BSIERP) developed to understand the processes that maintain this ecosystem. Once abundant in this region, baleen whales were severely depleted by commercial whaling during the 19th and 20th centuries. Since their protection, most species have been recovering and re-occupying historical habitats. Because they consume large quantities of prey, recovery of whale populations has the potential to modify the structure of the ecosystem. Therefore, understanding how environmental variables and prey influence whale distribution and abundance is important to predict how they can impact the ecosystem and how they will respond to changes in their environment. In this study, physiographic, oceanographic and biological variables were used to model the abundance of fin, humpback and minke whales in the EBS in 2008 and 2010. Species-specific generalized additive models (GAMs) were fit using the R package mgcv and model selection was performed based on GCV scores. The explained deviance of the most supported models ranged from 10.6% (fin whales) to 61.6% (humpback whales). Phytoplankton chlorophyll-a concentration (Chl-a), distance from the 200m isobath, and euphausiid biomass were important predictors of minke and fin whale abundance, species that had similar distribution patterns in the outer shelf of the EBS. In contrast, humpback whales showed a preference for shallow, coastal waters to the north of the Alaska Peninsula. Abundance of this species was correlated with sea surface temperature, euphausiid biomass, Chl-a, and depth. Results of this study provide strong evidence that the abundance of baleen whales is linked in varying degrees to oceanographic and biological processes in the Bering Sea. They also provide a quantitative assessment between the relationship of large whale density and environmental variables in the EBS early in the summer and a basis to further understand habitat preferences and potential impact from climate change.

*Bering Sea - Mammals***Three Different Survival Patterns Of Steller Sea Lions In Rookeries Along Asian Coast**

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Although the overall decline of Steller sea lions (SSL) has stopped and in many areas populations are recovering, SSL in the western and central Aleutian Islands have continued on a slow decline. Unfortunately, little data exists on SSL vital rates throughout their range and is completely lacking in the Aleutians. We analyzed resight data for the period 2002-2011 for 4,226 SSL branded as pups on 6 Russian rookeries in 1996-2008. One of these rookeries in the Commander Islands is less than 200 nm from the Western Aleutians. CJS models for open populations were used to estimate survival and sighting probabilities. Mean pup survival was significantly higher in the Commander Islands (COM) (0.71) and Eastern Kamchatka (KAM) (0.80) compared with the Kuril Islands (KUR) (0.60). Annual survival for juveniles aged 1 to 3 years old was significantly higher in KUR (Females (F):0.77-0.90, Males (M):0.72-0.87) than in COM (F:0.72-0.84, M: 0.67-0.80) and KAM (F: 0.70-0.88, M:0.65-0.85). At age 4 survival is significantly lower in COM (F:0.85, M:0.80) than KAM (F:0.91, M:0.88) and KUR (F:0.91, M:0.87). For females aged 5 - 11, survival was higher in KAM (0.89-0.93) than in KUR (0.88-0.91), and lowest in COM (0.85-0.87).. Juvenile survival was the same in COM and KAM but lower than in KUR, suggesting similar conditions for COM and KAM juveniles, and recent tracking data suggest they may share the same winter feeding areas. Cumulative survival of females to age 14 was twice lower in COM than in KUR and KAM. High pup survival rates in COM and KAM may suggest extended maternal care through at least the first year, which could cause some females, especially younger ones, to skip pupping one year, a tradeoff to protect their own survival. Adult survival from 4 -11 years was lower in COM for both sexes than in other areas. Typically in long-lived mammals adult survival is the last vital rate to decrease. Our observational data show that predation or other external causes of mortality are not likely important factors, suggesting that nutritional stress may be strongly affecting SSL in COM and possibly to some extent in KAM.

*Bering Sea - Mammals***Recent Use Of Northern Fur Seal (*Callorhinus Ursinus*) Specimens Collected By The Alaska Marine Mammal Tissue Archival Project (AMMTAP) To Investigate Contaminant Trends**

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In 1989, the National Marine Fisheries Service, Office of Protected Resources (NMFS/OPR), in collaboration with the National Institute of Standards and Technology (NIST) began the National Marine Mammal Tissue Bank (NMMTB) for long-term cryogenic archival of marine mammal tissues. The NMMTB is part of NMFS's Marine Mammal Health and Stranding Response Program and is maintained by NIST as part of its Marine Environmental Specimen Bank (Marine ESB). Marine mammal specimens from Alaska are provided to the NMMTB through the Alaska Marine Mammal Tissue Archival Project (AMMTAP) which was established in 1987. Protocols developed by NIST for collecting and archiving tissues for AMMTAP are designed to: (1) provide sufficient material for multiple analyses, (2) minimize the possibility of sample change and/or loss during storage, (3) minimize inadvertent contamination during sample handling and ensure sample integrity, (4) provide for long-term sample stability through cryogenic techniques, and (5) track and maintain a record of sample history. Recently, 49 liver and 50 blubber samples collected from 1987 to 2007 from sub-adult male Northern fur seals (*Callorhinus ursinus*) during annual subsistence hunts on St. Paul Island were analyzed for legacy persistent organic pollutants (POPs), current-use POPs, and vitamins. The legacy POPs determined in this study included polychlorinated biphenyl congeners (PCBs), dichlorodiphenyltrichloroethane (DDT), chlorobenzenes, chlordane compounds, and mirex. Recently phased-out and current-use POPs included in this study were the flame retardants, polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecanes (HBCDs), and the chemical surfactants, perfluorinated alkyl acids (PFAAs). Vitamins A and E were also assessed in the liver tissue collected. Inventory and protocols of AMMTAP as well as the results from the Northern fur seal study will be discussed.

*Bering Sea - Mammals*

**Bowhead Whale Acoustic Presence Compared To Sea Ice Concentration In The Bering Sea, 2004-2005, And Chukchi Sea, 2010-2011**

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The Western Arctic bowhead population migrates annually between the Bering, Chukchi, and Beaufort Seas with expansion and retreat of seasonal sea ice. While these movements are well known, much remains to be learned about factors influencing their specific timing and seasonal geographic distribution. We examine bowhead whale acoustic presence at autonomous recording sites in the Bering and Chukchi Seas, in recordings from 2004-2005 and 2009-2011, respectively. Seasonal presence is presented, along with local sea ice concentrations and chlorophyll a when available. We investigate correlations between these factors and bowhead acoustic presence at the two study sites.

*Bering Sea - Mammals*

## **Socio Economic Analysis Of Whale Watching Industry In Southern Coast Of Sri Lanka**

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Dolphin and whale watching is a new and blooming activity in Sri Lankan tourism industry. However, the present situation of this activity has been threatened marine mammals around Sri Lanka due to poor practices of the whale watching industry. Therefore, a scientific approach is needed for the understanding and the management of dolphin and whale watching activities, particularly in the Southern coast of Sri Lanka. A socio-economic survey was carried out in Mirissa, Southern coast of Sri Lanka from May 2011 to May 2012. The relevant data and information were collected through primary and secondary sources, through interviews with different stakeholders using pre-structured questionnaires. In addition to that, informal discussions were used to gather data. Secondary data were collected from different official reports, publications and books. A considerable proportion of the whale watching industry is responsible by foreigners visit from 45 countries, where the majority were from England, Germany, France, India, Russia & China. The total income from May of 2011 to May of 2012 is about LKR 294,767,058.70. Out of that, a considerable amount about LKR 290,410,999.20 (98.52%) earned within the whale watching season (from October to May). The highest income was LKR 62,282,158.00 earned during January 2012. There were clear differences among foreign visitor's in gender, age group, retaining time in Sri Lanka & preference to Southern coast, experience of whale watching and satisfaction levels. The negative behavior of the whale watching and its impacts on cetacean population are increasing with the development of the industry. Therefore a better understanding and a management system is needed to ensure the sustainability of this high profiting industry.

Key words: Whale watching, Sri Lanka



*Bering Sea - Mammals***The Sun, Moon, Wind, And Biological Imperative—Shaping Contrasting Wintertime Migration And Foraging Strategies Of Adult Male And Female Northern Fur Seals (*Callorhinus Ursinus*)**

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Adult male and female northern fur seals (*Callorhinus ursinus*) are sexually segregated in different regions of the North Pacific Ocean and Bering Sea during their winter migration. The reason why likely involves an interplay between physiology, predator-prey dynamics, and ecosystem characteristics, however possible mechanisms have lacked empirical support. To investigate factors influencing the winter ecology of both sexes, we deployed five satellite-linked conductivity, temperature, and depth data loggers on adult males, and six satellite-linked depth data loggers and four satellite transmitters on adult females from St. Paul Island (Pribilof Islands, Bering Sea, Alaska) in October 2009. Our results show that males and females migrated to different regions of the North Pacific Ocean. Horizontal and vertical movement behaviors of both sexes were influenced by wind speed, season, light (solar and lunar), and the ecosystem they occupied, although the expression of the behaviors differed between sexes. Male dive depths were aligned with the depth of the mixed layer during daylight periods when most foraging occurred across their winter range, and we suspect this was the case for females upon their arrival to the California Current. We suggest that females, because of their smaller size and physiological limitations, must avoid severe winters typical of the northern North Pacific Ocean and Bering Sea and migrate long distances to the south and east to areas of more benign environmental conditions and where prey fields are more accessible. In contrast, males can better tolerate cold and often extreme winter ocean conditions and exploit prey at depth because of their greater size and physiological capabilities. We believe these contrasting winter behaviors 1) are a consequence of evolutionary selection for large size in males, important to the acquisition and defense of territories against rivals during the breeding season, and 2) ease environmental/physiological constraints imposed on smaller females.

*Bering Sea - Mammals***Regional Differences In Mercury Concentrations In Alaskan Steller Sea Lions May Have Been Persistent Over The Past 15 Years.**

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Recent findings of relatively high total mercury concentrations ([THg]) in Steller sea lion (*Eumetopias jubatus*) pup hair from the Aleutian Islands have raised the question of whether [THg] has recently increased in this region. Whole blood archived from 1997 captures of sea lion pups at Seguam Island (central Aleutian Islands, n=15) and at Forrester Island (Southeast Alaska, n=23) were analyzed on a direct mercury analyzer on a wet weight basis for comparison to pups at Seguam Island in 2012 (n=13). The [THg] was also measured in whole blood collected from adult female Steller sea lions in the Aleutian Islands (1997, n=4 and 2011-2012, n=6) and in Southeast Alaska (1997, n=14 and 2010, n=3). No significant difference was found between median whole blood [THg] in pups between 1997 (0.094 µg/g; range 0.059 – 0.207 µg/g) and 2012 (0.081 µg/g; range 0.043 – 0.248 µg/g) at Seguam Island ( $Z=-1.1291$ ,  $p=0.259$ ). In 1997, mean whole blood [THg] measured in central Aleutian pups ( $0.128 \pm 0.068$  µg/g) was significantly higher (51% higher) than that measured in Southeast Alaska pups ( $0.085 \pm 0.048$  µg/g) which is similar to recent trends seen in hair [THg] measured in Steller sea lion pups across this range (Castellini et al. 2012, Rea et al. 2013). In 1997, [THg] in Southeast Alaska adult female blood was over 2 times higher than [THg] in pups from that same region ( $p<0.05$ ), however in that same year in the Aleutian Islands there was no significant difference between [THg] in the blood of adult female Steller sea lions and pups ( $p=0.618$ ). This comparison of temporal trends in [THg] is limited due to sample size of contemporary adult female captures. There were no significant differences in median [THg] between 1997 and post 2010 adult female samples in Southeast Alaska ( $p=0.059$ ) nor in the Aleutian Islands ( $p=0.286$ ). We conclude from these analyses that there have been no significant increases in mercury exposure of Steller sea lions in Alaska over the past 15 years, although a more complete retrospective analysis of archived blood samples would be warranted with increased statistical power.

*Bering Sea - Mammals***Does Diet Complexity Affect The Ability Of Northern Fur Seals To Meet Energy Requirements?**

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The current decline of northern fur seals on the Pribilof Islands has been hypothesized to be caused by a change since the mid-1970s in the quality of food available to them. Fur seals are known to eat a wide diversity of prey species composed of both high- and low-quality items. However, the net benefit of specific prey species to fur seals and whether different mixtures of prey result in a higher nutritional gain than mono-specific diets is unknown. We investigated the energetic value of different potential diets to evaluate whether changes in the prey composition available to Pribilof fur seals could be a key factor in their population decline. We conducted feeding experiments with six captive female northern fur seals subjected to eight, three-week diet trials that included four representative prey items consumed by fur seals in the Bering Sea (pollock, herring, capelin, and commander squid), fed alone and in combination. During each diet trial, we measured changes in body mass, lipid, protein, and energy digestive efficiency (via scat and fish proximate analysis), food intake and mass regulatory hormones (via blood samples), as well as heat increment of feeding and resting metabolism (via respirometry). Results from our study will increase understanding of changes in the efficiency of energy and nutrient absorption by fur seals as a result of a shift in diet. Our results will also allow the net energy intake of wild fur seals to be estimated from dietary information collected from northern fur seals in the eastern Bering Sea. Such data will allow the potential energetic status of fur seals in the wild to be calculated and will further knowledge of the bioenergetic impacts of dietary changes on population numbers.

*Bering Sea - Mammals***Development And Field Testing A Satellite-Linked Fluorometer For Marine Mammals: Shedding Light On The Unknown (Phase II)**

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Understanding the responses of marine mammals and other apex predators to spatial and temporal variability of primary productivity is fundamental for their conservation and for predicting how they will be affected by future climate change. Attaining this goal is often hampered by paucity of oceanographic data, but the use of animal-borne platforms as environmental sensors has quickly emerged to complement conventional oceanographic data collection methods, sample inaccessible locations, and provide real-time data of animal behavior corresponding to the abiotic vertical structure of the water column. Despite recent advances in biotelemetry, fluorometers have only recently been incorporated into transmitting systems. The purpose of this project was to incorporate a miniature fluorometer into a satellite-linked transmitter to provide measures of in situ phytoplankton fluorescence, which were used to calculate chlorophyll-a (chl-a), a proxy for primary productivity. After evaluating the suitability (i.e. size, power consumption, and electronic interface) of commercially available fluorometers, the ECO Puck™ (WET Labs, Inc., Philomath, OR), which measures chl-a (0-75 µg Chl/l), was interfaced with an archival instrument (i.e. SPLASH10), manufactured by Wildlife Computers, Redmond, WA. Laboratory trials and simulated deployments in the field (i.e. manual casts in Puget Sound, WA) indicated the interfaced prototype functioned properly relative to another calibrated instrument of similar configuration. Additionally, trials on trained, open water Steller sea lions (*Eumetopias jubatus*) allowed us to address concerns regarding the orientation and fragility of the optics. To determine the best approach for collecting, summarizing, and compressing data for transmission through the Argos satellite system, the prototype was deployed on an adult female northern fur seal (*Callorhinus ursinus*) captured on St. Paul Island, Alaska. The archived data (i.e. fluorescence, temperature, depth, and conductivity) collected at 4 Hz for all dives exceeding 10 m depth (range=10-120 m) during an eight day trip at sea were used to examine anomalous data, determine if the data reduction routines established for the Argos system were a sufficient summary of the data, and verify functionality of the Argos message generation by the transmitting unit. The final phase of this project will entail deploying a satellite-linked fluorometer on a free-ranging Steller sea lion.

*Bering Sea - Mammals***Retrospective Study Of Walrus Foraging And Movement Patterns During A Major Ecosystem Shift**

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Recent work suggests that anthropogenic climate change has caused a shift from arctic to subarctic conditions in the Bering Sea and resulted in replacement of ice-dominated benthic ecosystems with pelagic-dominated ecosystems. Some have hypothesized that this northward shift is influencing the movement, diet, and ecology of benthic predators. Few studies have addressed this question, however, because addressing it requires the collection of ecological data from benthic consumers from time periods prior to the observed ecosystem shift. The northward shift in benthic ecosystems has occurred in areas that support the largest breeding aggregations of Pacific walrus (*Odobenus rosmarus divergens*). Using walrus teeth collected during subsistence harvests, we are producing a 60-year time series of carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotope values with annual resolution for walrus in the northern Bering Sea. By comparing these data with the isotopic values of benthic invertebrate communities, we are assessing whether the northward shift in sea ice distribution has resulted in a concomitant northward shift in walrus foraging grounds. Preliminary data from walrus teeth collected from 1995–2005 ( $n=45$ ) demonstrate that  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values are negatively correlated, a pattern that mirrors north-to-south baseline gradients in the isotopic composition of their primary prey. Isotope data for teeth collected from 1950–60 ( $n=27$ ) are also negatively correlated, but most individuals have higher  $\delta^{13}\text{C}$  and lower  $\delta^{15}\text{N}$  values than walrus from 1995–2005. Isotope data for teeth collected from 1965–1985 ( $n=69$ ) are more variable with no obvious trend. Many individuals from 1965–1985 have higher  $\delta^{15}\text{N}$  values relative to walrus from the other time periods, suggesting a dietary expansion to high trophic level prey that included carnivorous gastropods and decapods. Overall, our data suggest that walrus  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values are primarily driven by north-to-south baseline gradients in this region, however, isotopic patterns that are best explained by an expansion of dietary breadth may have also occurred. Understanding how walrus have responded to the recent, unprecedented shifts in subarctic and arctic ecosystems is important for defining the ecological flexibility of this species.

*Bering Sea - Mammals***Observations On Marine Mammal By-Catch By Nearshore Seine Net Fisheries Off Eastern Kamchatka, Russia.**

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Marine mammals (MM) interactions with fisheries are poorly studied in Russian waters. The objectives of this study were to describe the seine net fisheries efforts from different vessels (RS-300, RS-600, STR-420) and to examine the probability of MM by-catch. Fishing was conducted in near shore (<15 km) area off the eastern Kamchatka coast. Observations were conducted on fishing vessels 13 Nov – 16 Dec, 2012 and 15 Feb – 7 Apr, 2013. Total observation effort was 35 days. During that time, 170 complete tows were surveyed. The total catch was 1,082 mt. Fish species composition was identified for 99.4% of the catch. The target species were pollock (48%), cod (38%), sculpins (5%), flatfish (4%), and other (5%). Most of the fishing parameters of these vessels were similar. Average tow duration was 75.4±1.02 minutes (n=120) and the fishing depth for all vessels ranged between 50 and 300m. However, the average catch per tow was significantly greater ( $p<0.04$ ) for RS-600 (mean=11.7 ±1.4 mt ) than for RS-300 and STR-420 (mean=3.1±2.02; 5±0.5 mt (range 0-40 mt), respectively), which was mostly due to the later fishing season. Pollock dominated in catch of RS-300 and RS-600 (71 and 58%, respectively), followed by sculpins (14%) for RS-300 and cod (34%) for RS-600. Catches of STR-420 consisted mostly of cod (56%) and pollock (23%). Fishing was conducted at daylight time only. Observations of MM sightings were conducted while boat transited from port to fishing grounds and back, and during all fishing operations. Total observation time was 370 hours. Twelve species of MM were recorded 72 times. Steller sea lion (SSL, *Eumetopias jubatus*) was the most frequently observed species (34 encounters, 47%), the second was minke whale (*Balaenoptera acutorostrata*, 8 encounters, 11%). No MM by-catch was recorded during our study. Interviewed fishermen reported that SSL by-catch occurred rarely in the seine fishery and usually happened in areas where SSL more abundant: near rookeries and haul outs. Results of our study suggest that most likely seine net fishery has no or little effect on SSL population, comparing to trawl and other types of commercial fisheries.

*Bering Sea - Mammals***Topographic Variation Of Blubber In Female Pacific Walruses: Relations To Caloric Intake, Season, And Condition**

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Rapid changes in sea ice are poised to impact patterns of productivity in Arctic marine ecosystems, and have already altered habitat use and activity patterns of female Pacific walruses (*Odobenus rosmarus divergens*). Walruses may be unable to meet daily energetic demands in this new regime. Blubber thickness over the xiphoid process of the sternum is measured to evaluate the body condition of free-ranging walruses, but blubber in specific regions of the body may be preferentially targeted to balance energy demands. Animals in aquaria provide the opportunity for controlled study of how blubber responds topographically to alterations in caloric intake. We examined the morphology, body mass, blubber thickness at 21 sites, and caloric intake of five mature, non-pregnant female Pacific walruses for a minimum of one year. As might be expected, body condition (mass straight length<sup>-1</sup>) was best described by a model including a seasonal effect and caloric intake, and body condition scaled positively with estimates of total blubber mass. Although blubber thicknesses (1.91 - 10.69 cm) were similar to values reported for free-ranging mature, non-pregnant female Pacific walruses, blubber thicknesses varied topographically. Body conditions were most closely related to blubber thicknesses measured dorsally in the region of the anterior insertion of the pectoral flippers; blubber thicknesses at the sternum were relatively poor indicators of condition. These results demonstrate the value of validating condition metrics by using a controlled observational approach before using these tools to monitor the health of free-ranging populations.

*Bering Sea - Mammals***The SSL Pup Count (*Eumetopias Jubatus*): Error Count Associated With Increasing Pups Activity.**

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SSL pups were counted from July to the end of August on Tuleny Island (Russia, Sakhalin). At the end of the field season number of counted pups declined and daily variation in SSL pups number increased. But pups do not leave the rookery till the end of August. Therefore, we calculated an error that occurred when pups activity increase. All observation time was divided into 5-days periods. In each of this period, an average pups number was count. After the pups number reached its maximum (01.07-05.07; MX=725 animals), we started to calculate number of non-counted pups. The following formula was used for these calculation:  $uPx=(mP-Px)/mP$ , where  $uPx$  - part of non-counted pups per day X;  $mP$  - maximal number of counted pups (725 individuals);  $Px$  - number of pups counted per day X. Portions of non-counted pups were averaged for each 5-days period. Also the 95 % confidence interval was calculated. The calculated confidential intervals form an error corridor in which with 95 % chance the real average portion of non-counted pups lie. The SSL pups count error fluctuated from 0 to 20 %, and its average level significantly changed within the season. At the second decade of July number of non-counted pups started to increase rapidly, and reached on average 1/3 of the total pup count. In August from 1/3 to 1/2 of all pups were non-counted. Currently, the calculated levels of errors is specific only for Tuleny Islands because the sample size for this calculations was very small.



*Bering Sea - Mammals***Pacific Walrus Haulout Disturbance And Recovery**

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Pacific walrus have been listed as a Candidate Species under the Endangered Species Act due to potential for climate change-induced loss of their summer sea-ice habitat that they rely upon for resting, foraging, and reproduction. Established summer terrestrial haulouts are generally utilized by male walrus, while females and calves primarily rely on sea ice year round as a haulout substrate. As summer sea ice continues to retreat, new terrestrial haulouts are emerging and will become critical to support all segments of the walrus population. This is of concern for females and calves due to the increased threat of disturbance and trampling on terrestrial haulouts. The objective of this study is to assess disturbance and recovery of a terrestrial walrus haulouts. Historic male terrestrial haulouts have been in use for decades and the locations are well documented in Bristol Bay. In contrast, the emergent female and calf terrestrial haulouts are less predictable and therefore harder to monitor. To address the objectives of this study four time lapse cameras were deployed to monitor the activity on the beach and the adjacent waters around Cape Seniavin, Alaska. Serial images from these cameras were analyzed to determine disturbance mechanisms, impact, and time for recovery to a haulout. These camera observations were a non-invasive means to collect long term data with little to no disturbance to the study animals. Anthropogenic disturbances such as boats on the water, boats landing on the beach, human foot traffic, and aircraft were recorded as well as natural disturbances by bears. Intensity of disturbance and recovery time elevated with repeated occurrences on the same day. Behavioral observations made at male walrus haulouts, where their locations are predictable, can inform policy for the protection of female and calf haulouts when and where they occur.

*Bering Sea - Mammals***Pacific Walrus Haulout Abundance And Counting Efficacy In Alaska**

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Pacific walrus (*Odobenus rosmarus divergens*) haul out by the thousands in specific areas throughout western Alaska. Although they have historically used drifting ice floes as habitat, reduced Arctic sea ice has made them much more reliant on terrestrial haulouts. They display high site fidelity, frequenting the same beaches year after year. This provides an opportunity to monitor the walrus using fixed position camera equipment. The camera system used here allows determination of walrus abundance and density without the excessive cost, risk, and logistics involved with sending a field crew to do the counts in person, by hand. While this project uses still photographs to obtain counts over time, there are also areas where crews are sent into the field to count animals on site using tally counters. One such site is the state managed Round Island in northern Bristol Bay. Round Island is the only site in this study that is counted using photographs as well as by a field crew living on the island. Since the animals of the same haulout are being counted by camera and on site, the accuracy of these two counting methods may be compared. This presentation will begin with abundance counts and trends at all sites at which the cameras have been deployed. In 2012 (the year from which this data was collected) the sites include three in Bristol Bay: Cape Seniavin, Cape Peirce, and Round Island along with two Arctic sites: Cape Lisburne and Point Lay. It will then focus on the analysis of count efficacy via photographs taken using the automated camera system versus a field crew counting on site. If acceptable accuracy can be attained by counting animals in a picture instead of counting in the field, this study holds implications as to the need to send people into remote, often dangerous areas to accomplish this task.

*Bering Sea - Mammals***Spring 2013 Aerial Survey Of Ice Associated Seals In Russian Far East**

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In spring 2013 the second phase of the instrumental aerial survey of Pacific ice associated seals was successfully complete. The research was conducted within the framework bilateral Russia-US environmental protection agreement. The survey of ice-covered water areas was conducted both in American and Russian parts of the Northern Pacific simultaneously. The main goal of the study was developing an instrumental method for aerial survey to estimate current abundance of four Phocidae species; spotted, ringed, bearded, and ribbon seals. To get the uniform data both the American and Russian scientists used the unified method for aerial seal survey. This approach allowed to combine the survey results of both countries and calculated total abundance of ice seals in the northern Pacific. In the Russian part surveys were carried out over the ice covered waters of the Sea of Okhotsk and the western Bering Sea from April 5th to May 9th 2013. The flights were conducted using aircraft Antonov-38 "Vostok" at altitude of 200-250 m with the average speed 260 of km/h. The aircraft was equipped with an IR scanner "Malachit-M", three Nikon D800 and one GoPro Hero 3 cameras, navigation system, three visual observers, and an automatic system for flight data recording. A selective method of randomly distributed linear transects was used. The flights were planned using the most recent satellite images of ice distribution. During the flight hot spots of the seals hauled out on ice were first detected by the IR scanner, than high definition digital cameras (1 px = 2-5 cm<sup>2</sup>) automatically were turned on. The species composition and sex-age identification of the seals were retrieved from photographs after survey. Visual observers using bubble windows recorded information on animal behavior (engine sound disturbance, etc.), sightings other marine mammals (walruses, whales) and the weather data. The total survey flight duration in Russian waters was 108 hours, transect length reached 23,000 km, area swath around 14,000 km<sup>2</sup>, IR imaging recording duration up 70 hours, and 92,250 digital photographs collected. The work was conducted under the grant AB133F10CN0355 provided by National Marine Fisheries Service, NOAA, USA.

*Bering Sea - Mammals***Preliminary Results Of Ice-Breeding Seals Aerial Survey In April 2012 In Karaginsky Gulf, Russia****Vladimir Chernook**, Chernook@mail.ru

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An aerial survey of ringed, bearded, spotted and ribbon seals in Karaginsky Gulf was conducted on 20, 21 and 23 April 2012, within the framework of the Russian-American BOSS project. We used the aircraft AN-38 equipped with infrared scanners, digital cameras and on-board computer system for data recording. In total 2,100 km of randomly selected line transects were flown over the ice at 250-300 m altitude. Total ice covered area >1,100 km<sup>2</sup> was surveyed. Simultaneously, visual observations were made to record seal behavior and sightings of marine mammals in the water. The quality of pictures allowed species identification and seal length measurement. In total 1,327 seals were recorded on IR images with a mean density of 1.12 individuals/km<sup>2</sup> (SD=1.45). Extrapolation of survey results to the whole ice covered area gave us a preliminary estimate of seal abundance on ice in Karaginsky Gulf during the survey of 31,900 (95%CI: 30,200-33,700) individuals. The proportion of different species, calculated based on a random sample of 274 digital photographs, was: ringed seal 49%, spotted seals 30%, bearded seals 16%, and ribbon seals 5%. Ringed seals were sighted on fast ice, spotted and ribbon seals were on the edge of drifting pack ice, and bearded seals were evenly distributed on drifting ice. Ringed seals were most sensitive to disturbance caused by the aircraft, but the proportion of them going into the water did not exceed 15%. Other species reacted similarly and appeared to be less sensitive. Only 5% of them went into the water. Our calculations differ from the results of visual aerial surveys in Karaginsky Gulf conducted in 1979, 1986 and 1987 in terms of estimated seal abundance and species composition. It might be due to different survey methods, high variability in proportion of animals hauling out on ice during the surveys, and, possibly, seasonal and interannual differences in seal presence in studied area. Additional time for data processing and comparative statistical analyses are required to refine the instrumental aerial survey results and make final conclusions. The work was conducted under the grant AB133F10CN0355 provided by National Marine Fisheries Service, NOAA, USA.

*Bering Sea - Mammals***Apparent Age Of First Reproduction In Steller Sea Lions On Russian Rookeries**

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Age of first reproduction (AFR) is a key parameter in demographic studies. Steller sea lions (SSL) can ovulate as early as age 3 and give birth at age 4, but majority of females give first birth at age 5. However, there is little information available on the variability of this vital rate among different rookeries, geographic areas, or stocks. We used behavioral observations to record apparent AFR at six rookeries across the Russian Far East in 2002-2011. Five rookeries were within the Asian population and one was belong to Western stock. We recorded birth events in 411 SSL females age 4 - 14 branded as pups in 1998-2007. Only 55 (13.4%) females were first seen with a pup at age 4; 212 females (51.6%) at age 5; 80 (19.5%) at age 6; 16 (3.9%) at age 7; and 6 (1.5%) at age 8 y.o. We did not observe any females giving birth for the first time at age 9 or older. Forty-two females (10.2%) were never seen giving birth or nursing a pup and were excluded from further analysis. The mean AFR on Russian rookeries was  $5.2 \pm 0.13$  y.o. (95% CI, range 5.0-5.4) and was only slightly higher than the mean of first pregnancy rate ( $4.9 \pm 1.2$ ) estimated for Alaskan SSL in the late 1970s by Pitcher and Calkins (1981). The difference fades when prenatal mortality is considered. The AFR varied among rookeries, but no significant differences were found between Western (Medny rookery) and Asian (all other rookeries) stocks. Differences were significant only between two sites in the Kuril Islands, Raykoke and Brat Chirpoev (z-test,  $p = 0.005$ ). Among primiparous females that had at least one birth event during our study ( $n = 369$ ) the first pup birth rate at age 4 was  $0.149 \pm 0.056$  (mean  $\pm$  95% CI; range 0.075-0.229); at age 5 -  $0.574 \pm 0.047$  (range 0.509-0.636); at age 6 -  $0.219 \pm 0.075$  (range 0.159-0.358); at age 7 -  $0.040 \pm 0.028$  (range 0.000-0.069); and at age 8 -  $0.018 \pm 0.023$  (range 0.000-0.060). AFR varied widely across studied range and time and such differences could be important determinants of the divergent SSL population dynamics and trends.

*Bering Sea - Mammals***Steller Sea Lion Decline At Medny Island Rookery, Russia, In Summer 2013**

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In the Commander Islands, Steller sea lions (SSL) breed only at one location, on Medny Island. The rookery has been surveyed in the breeding season every year since 1959. Composite counts, brand resights, and breeding performance of individually identifiable animals was monitored daily from May 9 to September 7 2013 by 2 observers and 4 time-lapse cameras (122 days). The cameras were installed throughout the rookery and took photographs at 5 min intervals from dusk to dawn. The mean number of non-pup SSLs on rookery at the end of breeding season (June 20-July 10) was only  $244 \pm 8.6$  (95%CI) individuals, which was 28% less than the mean count over the last 10 years. The maximum SSL non-pup count during the last 10 years on this rookery dropped from 532 in 2008 to 291 individual in 2013 (-43.5%). It was the lowest count on this rookery at the end of breeding season since the 1960s. The ten year trend in non-pup abundance on the Medny rookery was -7.0% per year. A total of 167 pups were born on Medny (-21% to 10yrs average) in 2013. It was the lowest pup production in 25 years. Over the last 10 years pup production has fallen 3.3% per year. The general condition of SSLs during the breeding season was normal and postnatal pup mortality was only 2.4%. Since 1986, a total of 1,021 pups were branded on Medny I. A total of 108 (10.6%) branded SSL were recorded on their natal rookery during summer 2013, which is only 3.3% less than the 10yr mean ( $13.9 \pm 2.08\%$ ; 96%CI) return. The trend in proportion of branded SSL that returned to their natal rookery was only -0.07% over the last decade. Differences in numbers and trends of non-pups and marked SSLs on the Medny rookery suggest that the actual decline in non-pup SSL abundance is much lower than calculations based on visual counts. We suggest that the majority of non-pup SSLs return or visit the rookery during the breeding season, but for a short time only and that mature females more and more often skip breeding there.

*Bering Sea - Mammals***Long-Term Surveillance Of SSL Rookeries With Time-Lapse Cameras In Russia And Alaska**

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The Steller sea lion (SSL) has strong site fidelity to its rookeries and haulouts. Once established, these sites can persist for dozen or even hundreds years. This allows the use of automated time-lapse cameras (TLC) for long-term surveillance of SSL sites to collect information on presence/absence on land, diurnal and seasonal abundance changes, age and sex composition, events of disturbance and mortality, and monitoring of branded individuals and their activity, breeding performance, and first months of pup survival. Use of TLCs is also advantageous in facilitating monitoring during extreme weather conditions (e.g. severe storms, surge, tsunamis, etc.) that could effect SSL pup survival. In spring and summer of 2012, a total of 30 TLC sets were tested on 10 SSL rookeries in western Alaska and Russia (2-6 sets per site). Each TLC was custom built, containing a high resolution DSLR camera (Canon T3 or Sony A390), zoom lens (18-300 mm), timer, power adapter, light sensor, all placed into a waterproof Pelican case with a small window and weather hood. Power was provided by a charge regulated solar panel. Each TLC was completely autonomous and automatically took pictures of a portion of the rookery from dusk to dawn at preset time intervals. By July 2013, cameras were present on rookeries  $330 \pm 16.7$  (range 74-469) days, of which  $289 \pm 19.3$  (range 23-469) days they collected photographs. Twenty (76.7%) cameras operated daily 100% of the time. Ten (33.3%) TLC sets suffered technical malfunctioning caused by solar panel contacts corrosion (4 sets), severing of power wire by small rodents (3 sets), operator errors during installation (2 sets), or timer issues (1 set). TLC photo intervals varied from 3 to 55 min. On average, one set took  $50 \pm 0.8$  (lim 1-571) images/day. During their deployment, a total of 431,102 images were collected and archived. Analysis of images collected during the 2012 breeding season at 4 SSL rookeries in the Kuril Islands yielded a comparable amount of SSL brand resight information as two observers that worked all day in alternating 8 hour shifts. These test demonstrate the high potential of TLCs for long-term monitoring of SSL rookeries and haulouts.

*Bering Sea - Mammals***Decline Of Gastric Lesions In The Stomachs Of Northern Fur Seals (*Callorhinus Ursinus*) Associated With A Decline In Abundance Of Gastric Nematodes, St. Paul Island, Alaska**

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Population of northern fur seals (*Callorhinus ursinus*) (NFS) in the Bering Sea and North Pacific have declined during last 40–50 years. Recent studies (Kuzmina et al., 2012, 2013) have shown that the abundance of gastrointestinal parasites also have declined from the 1960's. These helminths are capable of causing lesions in the gastric mucosa characterized by sub-mucosal nodules and active and healing ulcers. These lesions are caused by the feeding activity of the parasites. Gastric ulcers associated with nematodes were first described in California sea lions (Schroeder and Wegeforth, 1935). Similar lesions were described in stomachs from subadult males NFS collected from St. Paul Island, AK (1987-1997) that were examined for the presence of anisakid nematodes and examined histologically. From these 5,950 NFS stomachs only 8% had no lesions, 92% had small nodules, 14% had active ulcers and 10% had healed ulcers (Spraker et al., 2003). Moreover; it has recently been found that these gastric nematodes can perforate the gastrointestinal tract and cause peritonitis and kill older NFS pups. Monitoring studies of NFS infections with gastrointestinal helminthes were performed during July–August, 2011 – 2013 on St. Paul Island. Totally, stomachs of 609 NFS males humanely harvested during Aleut subsistent harvests were collected, examined for the presents of gastric parasites and the number of nodules and active and healing ulcers were counted. The results were that 72.3% of NFSs examined had no lesions in the stomach, 21.5% of seals had nodules, 5.3% – healed ulcers and 0.9% had active ulcers. These data corresponds with decreasing of number of anisakid nematodes parasitizing NFS stomachs (Kuzmina et al., 2012, 2013). Even though the numbers of gastric lesions had dramatically declined the histological changes associated with the lesions (infiltration by macrophages, plasma cells, lymphocytes, neutrophils and multinucleate giant cells surrounded by fibroplasia) were similar as seen in the late 1980's and early 1990's. Further studies are necessary to monitor current trends in host-parasite interactions in NFS population and influence of gastrointestinal parasite infection on the health of the seals especially if these gastric parasites can kill 8-10 month old pups.



*Bering Sea - Mammals***Monitoring Of The Gastrointestinal Helminth Community Structure Of Northern Fur Seals (*Callorhinus Ursinus Linnaeus, 1758*) On St. Paul Island, Alaska In 2001-2013**

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The population of northern fur seals (*Callorhinus ursinus*) (NFS) in the North Pacific and Bering Sea has been decreasing over the last 4-5 decades. Most of the NFS gastrointestinal parasites have an indirect life cycles involving intermediate/paratenic hosts (crustacea, fishes and squids) which are sources of seal infection. Three-year studies were performed at St. Paul Island, Alaska to examine the current state of the NFS helminth community abundance and biodiversity. The studies were carried out during July–August 2011–2013. Gastrointestinal tracts of 609 NFS males were examined during the annual Aleut subsistence harvests. All helminthes (17,929 specimens) were collected and identified. All NFSs examined were infected by gastrointestinal helminthes. Totally, 16 species were found. Prevalence of NFS infection by gastric nematodes was more than 90% (in 2011 – 92.8%; 2012 – 90.4%, 2013 – 93.1%). Mean intensity of NFS infection also was similar during this period: in 2011 – 9.7, 2012 – 10.9 and 2013 – 8.7 specimens per host. Four species (*Anisakis simplex*, *Contracaecum osculatum*, *Pseudoterranova decipiens*, *P. azarazi*) were found. Prevalence of NFS infection with cestodes was similar during three years: 98.1%, 96.7% and 99%, respectively; while mean intensity increased from 12.5 in 2011 to 19.3 in 2013. Two cestode species (*Diphyllobothrium pacificum*, *Diplogonoporus violettae*) were identified. Prevalence of NFS infection with acanthocephalans increased during the last three years (in 2011 – 37.9%; 2012 – 39.3%, 2013 – 49.8%), while intensity was similar: 2.2, 3.3, and 3.0. Seven species of genera *Corynosoma* and *Bolbosoma* were found. Prevalence of NFS infection with trematodes was 34.2% in 2012 and 36.5% in 2013; mean intensity decreased from 11.2 specimens per host in 2012 to 7.2 in 2013. *Phocitrema fusiforme*, *Pricitrema zalophi* and *Stictodora* spp. were found. The three-year studies showed stability of the gastrointestinal parasite community abundance and biodiversity during this period. However, comparison of our data with data of previous researchers (Keyes, 1964; Spraker et al. 2003) revealed significant changes in NFS parasite community structure during the last 50 years. Further monitoring studies are necessary to elucidate connections of parasite community structure and changings in NFS diet during this period.

*Bering Sea - Mammals***Long-Term Surveillance Of SSL Rookeries With Time-Laps Cameras In Russia And Alaska**

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The Steller sea lion (SSL) has strong site fidelity to its rookeries and haulouts. Once established, these sites can persist for dozen or even hundreds years. This allows the use of automated time-lapse cameras (TLC) for long-term surveillance of SSL sites to collect information on presence/absence on land, diurnal and seasonal abundance changes, age and sex composition, events of disturbance and mortality, and monitoring of branded individuals and their activity, breeding performance, and first months of pup survival. Use of TLCs is also advantageous in facilitating monitoring during extreme weather conditions (e.g. severe storms, surge, tsunamis, etc.) that could effect SSL pup survival. In spring and summer of 2012, a total of 30 TLC sets were tested on 10 SSL rookeries in western Alaska and Russia (2-6 sets per site). Each TLC was custom built, containing a high resolution DSLR camera (Canon T3 or Sony A390), zoom lens (18-300 mm), timer, power adapter, light sensor, all placed into a waterproof Pelican case with a small window and weather hood. Power was provided by a charge regulated solar panel. Each TLC was completely autonomous and automatically took pictures of a portion of the rookery from dusk to dawn at preset time intervals. By July 2013, cameras were present on rookeries  $330 \pm 16.7$  (range 74-469) days, of which  $289 \pm 19.3$  (range 23-469) days they collected photographs. Twenty (76.7%) cameras operated daily 100% of the time. Ten (33.3%) TLC sets suffered technical malfunctioning caused by solar panel contacts corrosion (4 sets), severing of power wire by small rodents (3 sets), operator errors during installation (2 sets), or timer issues (1 set). TLC photo intervals varied from 3 to 55 min. On average, one set took  $50 \pm 0.8$  (range 1-571) images/day. During their deployment, a total of 431,102 images were collected and archived. Analysis of images collected during the 2012 breeding season at 4 SSL rookeries in the Kuril Islands yielded a comparable amount of SSL brand resight information as two observers that worked all day in alternating 8 hour shifts. These test demonstrate the high potential of TLCs for long-term monitoring of SSL rookeries and haulouts.

*Bering Sea - Seabirds***What Does Colony Recovery Look Like For Auklets On A Catastrophically Disturbed Island?**

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Volcanic activity in the Aleutian Islands has shaped the habitats and behavior of the species that use them. The 2008 eruption of Kasatochi volcano, in the Central Aleutians provided researchers with a natural experiment allowing us to observe the response of Auklet species that nested on the island prior to the August 2008 eruption. Although nesting habitat was uniformly eliminated for Crested Auklets (*Aethia cristatella*), Least Auklets (*Aethia pusilla*), and Parakeet Auklets (*Aethia psittacula*), the processes affecting the availability of nesting habitat, and consequently the recovery of these colonies, have been quite different. High rates of erosion have done little to open up nesting habitat for Crested or Least Auklets, but yielded ever larger areas of beach bolder habitats suitable for Parakeet Auklets. Coastal counts confirm increasing numbers of Parakeet Auklets around the island since 2010. In contrast, Crested and Least Auklets, which rely on talus nesting habitats, remained with virtually no usable nesting habitat until 2011 when a large rockfall in Whiskey Cove provided nearly a hectare of surface talus that was immediately occupied. All three species have shown signs of recovery, but have relied on two different physical processes for the recovery of their habitats. This rapid recovery of nesting habitats is encouraging and suggests these populations are resilient. These findings should serve to focus future work on future large-scale disturbances.

*Bering Sea - Seabirds***Migratory Patterns And Wintering Range Of Crested Auklets In The Bering Sea And North Pacific**

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Crested Auklets are known to breed in the millions on remote islands in the Bering Sea and North Pacific, but their wintering areas and migration patterns are virtually unknown. Understanding the at-sea distributions of seabirds during their entire annual cycle is essential for population conservation and management, as environmental and anthropogenic threats vary across marine regions. The use of light-sensing archival geolocation tags ('geolocators') is currently one of the prevalent methods of quantifying seabird movement and migration. Our primary objectives are 1) to test effects of a newly-released extra-light-weight geolocator on Crested Auklet fledging success, parental provisioning and nest site fidelity 2) to measure extent of intraspecific variation in migration patterns and timing as well as wintering areas, 3) to explore factors affecting Crested Auklet at-sea distribution using remotely sensed oceanographic data, and 4) ultimately to assist in development of methods to predict population consequences of climate change and anthropogenic stressors like oil spills and fisheries bycatch. In 2013, we deployed 91 Migrate Tech Intigeo C-65 geolocators (1 g) on adult breeding Crested Auklets at Buldir and Gareloi (230 miles apart), two large breeding colonies in the Aleutian Islands. Our preliminary results on tag effects show no difference in fledging success between nests of tagged adults and nests of untagged adults. With a conservative estimate of Crested Auklet nest site fidelity at roughly 60-80%, we hope to retrieve at least 50 geolocators in summer 2014. Future work will focus on analysing the degree to which migration in Crested Auklets varies in time, space, and duration as well as characterizing critical overwintering habitat.

*Bering Sea - Seabirds*

**The Pribilof Island Seabird Youth Network**

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The Seabird Youth Network is a partnership between the Pribilof School District, the Aleut Community of St. Paul Island, the St. George Traditional Council, the Alaska Maritime National Wildlife Refuge (AMNWR), and the wider scientific community. The network creates exciting opportunities for youth on the Pribilof Islands to learn about seabirds and contribute to long-term seabird monitoring programs. The program also provides students opportunities to gain experience in a range of marketable media skills. Desktop movies are a powerful tool for capturing students' enthusiasm for learning. The Alaska Teen Media Institute visited the Pribilof Islands twice last year, working with students on both islands to produce their own seabird documentary. The 6/7th grade class on St. Paul created the first movie. This class had spent the school year learning about seabirds through a team-mentorship program between a seabird researcher and their teacher. During this program, seabird fact sheets covering a different seabird topic each month were provided to the teacher, classroom lessons were designed around each topic, and lessons were followed up by a monthly Skype session with a seabird researcher. The movie introduces viewers to their community and what they have learnt through these Seabird Youth Network classroom sessions. Students on St. George produced the second movie during the summer seabird camp. Seabird camps were held on both Pribilof Islands in 2013, with over 40 students participating. Camp members studied the basics of seabird biology, learned about the traditional use of seabirds on the Pribilof Islands, assisted with the collection of long-term seabird monitoring data, learnt about the AMNWR seabird monitoring program, created an educational Rat-Free poster, installed least auklet nest boxes, oh, and...had fun!

*Bering Sea - Seabirds***Mercury Concentrations In Tissues Of Kittlitz's Murrelet From Glaciated And Non-Glaciated Regions In Alaska**

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The Kittlitz's murrelet (*Brachyramphus brevirostris*), an endemic piscivorous seabird found only in Alaska and the Russian Far East, is a species of conservation concern. Mercury is a non-essential, toxic metal that is increasing worldwide. Due to the biomagnification of mercury within marine food webs, many piscivorous seabirds are at risk of exposure to elevated levels of mercury. We compared total mercury concentrations in guano, eggshells, blood, and breast feathers of adults and chicks from two glaciated regions in southeastern Alaska (Icy Bay and Glacier Bay) to two non-glaciated regions in the Aleutian Islands (Adak Island and Agattu Island). All sites sampled support breeding populations of Kittlitz's murrelets. We found significant differences in mercury concentrations among tissues and sites. The pattern of mercury concentrations in murrelet tissues was: adult breast feathers > chick breast feathers >> blood >> eggshells  $\approx$  guano. Adult Kittlitz's murrelet mean breast feather mercury concentrations from Adak Island and Glacier Bay were above the toxic threshold value of 5000 ppb hypothesized for other birds and were significantly greater than those from Agattu Island or Icy Bay. Furthermore, two individuals from Glacier Bay had mercury levels high enough ( $\geq 30,000$  ppb) to warrant concern for direct mercury exposure to their predators. Mercury concentrations in murrelet guano, eggshells, and blood do not appear to represent immediate threats, but more information on the physiological effects of mercury on Kittlitz's murrelets is needed. Importantly, based upon feather mercury concentrations, our findings suggest that Kittlitz's murrelets from Adak Island and Glacier Bay may approach levels associated with impaired reproduction in other bird species, and merit further study.

*Bering Sea - Seabirds***Biological Age, Along With Sex And Habitat, Influences Foraging Behavior Of Bering Sea Thick-Billed Murres**

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In long-lived animals, aging results in both improvements in performance due to previous experience and physiological deterioration (senescence). The relative contribution of these two potentially opposing processes is expected to be managed differently depending on environmental quality, life history, and sex roles within the species. Here we examine the effects of biological age (indicated by telomere length), sex, and foraging habitat (as determined by colony of origin) on three axes of foraging habitat selection (assessed via bird-born data loggers) in breeding thick-billed murres (*Uria lomvia*). Foraging habitat was defined by spatial habitat choice (foraging radius, sea-surface temperature, average foraging depth, and maximum foraging depth), temporal use (day/night preference and foraging time budget), and prey selection (stable isotope signatures of carbon and nitrogen). As expected, sex and habitat contributed strongly to explaining foraging behavior. Biological age also played a large role, weighted comparatively highly as sex or colony in most analyses. Interactions were key: biological age and sex interacted to predict spatial use of the environment, indicating potential niche partitioning by sex. Partitioning by sex may reduce intra-pair competition and promote a diverse food array for self-foraging and feeding young, highly beneficial strategies. Biological age interacted with habitat to predict patterns of prey selection. Oceanographic features and prey availability likely drove these differences in aging strategies along colony lines. We found no evidence of senescence in either behavioral parameters or physiological (e.g. dive depth). Every analysis indicated that colony must be taken into consideration and that the effects of aging depend heavily on the habitat in which they are expressed. As expected sex also plays a major role in explaining foraging behavior, but here we show as well that an indicator of biological age plays a similarly decisive role in explaining variation in foraging behavior.

*Bering Sea - Seabirds***The Alaska Puffin Diet Database (APDD): A Tool For Understanding Food Web Dynamics In Remote Marine Ecosystems**

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Forage fish are critical to marine ecosystem functions, but are poorly known in Alaska. Owing to their importance, however, the North Pacific Fisheries Management Council places severe limits on forage fish fisheries. The distribution and abundance of forage fish (e.g., sand lance, capelin) is known from a few small-scale studies, but information on large-scale spatial and temporal variability in this community and relationships to predatory fish and wildlife is lacking. Seabirds are conspicuous predators that can travel great distances (100+ km from colonies) and dive to great depths (200 m) to efficiently locate and capture (i.e., sample) ephemeral forage fish. Thus, data on the food habits of seabirds may provide a valuable complement to traditional forage fish sampling methods. Herein, we describe a large, standardized database of seabird diet data that includes prey species composition and size (mass and length). Diet data were obtained by the Alaska Maritime National Wildlife Refuge and U.S. Geological Survey from 1978 - present. For three puffin species, horned puffin (*Fratercula corniculata*), tufted puffin (*F. cirrhata*), and rhinoceros auklet (*Cerorhinca monocerata*), we have collated nearly 100,000 prey observations from ~40 sites throughout Alaska, with a concentration in the Aleutian Islands – Bering Sea ecosystem. Most of the data (~80%) came from six islands: Suklik, Aiktak, Middleton, St. Lazaria, Midun, and Buldir. Aiktak Island had the most years of data (n=24), while St. Lazaria had the longest continuous time series of 19 years. A total of 112 prey species were sampled including forage fishes, cephalopods and other invertebrates. The five most abundant forage fish in puffin diet were Pacific sand lance, walleye pollock, euphausiids, squid, and greenling. A large number of samples included information on length and mass of prey items, allowing estimation of the biomass of forage fish consumed by Alaska puffins. This information will be useful in understanding the role of forage fish in Alaskan marine ecosystems and provide key quantitative data for the ecosystem approach to fisheries in the region.



*Bering Sea - Seabirds*

**A Web-Based platform For Science Education And Community Involvement**

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The Pribilof Islands are home to two Aleut populations and an estimated two million seabirds. The Pribilof Island Seabird Youth Network aims to build local capacity for the collection of long-term seabird monitoring data on the Pribilof Islands through education and active participation in data collection. The network uses a website as a platform for sharing seabird lessons with students and the wider teaching community, and learning about seabird monitoring, research, and conservation. An online blog: (a) shares updates and results of the summer seabird camps and overall project; (b) profiles individual researchers and current research tools, and (c) covers seabird and marine conservation stories in the news. The website is designed to be inviting and user-friendly for a range of ages. The poster highlights aspects of the web that have been most useful as a teaching tool, and encourages scientists and teachers to team-mentor students.

*Gulf of Alaska - Climate and Oceanography***Delineating A Physical And Biological Break Point Between The Eastern And Central Gulf Of Alaska**

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The highly complex and dynamic marine environment in the Gulf of Alaska (GOA) supports a rich and diverse ecosystem which exhibits strong gradients in population stability and species composition over space and time. It has been hypothesized that environmental and biological variability are less pronounced in the eastern GOA than the central and western GOA, and the greater stability and higher species diversity in the east make the region more ecologically resilient to climate change and human forcing. These regions are likely affected by top-down and bottom-up effects in dissimilar ways and forecasting tools and management approaches must account for such differences. Although there are obvious differences in the biology of the two regions, these have not been fully characterized and it remains unclear whether the faunal break is linked to a similar break in climatic or oceanographic conditions that may help elucidate reasons for the faunal break. The objectives of this study are to quantify the variability of key physical and biological drivers in the GOA and to delineate a physical and/or faunal break between the eastern and central GOA for use in modeling and management efforts. To identify the location of the break, we examined gulf-wide patterns of variability in multiple variables, including sea surface temperature (SST), chlorophyll-a (chl-a), photosynthetically-available radiation (PAR), upwelling, and fish community structure and abundances from bottom-trawl and long-line surveys. Breakpoints were identified using a combination of EOF, GAM, and cluster analyses, and were similar for all variables examined, supporting an oceanographic basis for the observed faunal break. Breakpoints on the shelf occurred at 148.4°W for SST, 148.5°W for chl-a, 149.8°W for PAR, 148.0°W for upwelling, and 148.2°W and 150.2°W for total bottom-community abundance and diversity. There was also a substantial change in bottom-community composition on the shelf at approximately 149.6°W. These locations coincide with the region where the Alaska coastal current (ACC) transitions from an eastern to a western boundary current. Offshelf breakpoints in PAR, SST, and chl-a occurred further upstream, suggesting that the signal associated with the physical breakpoints may originate offshore before propagating onto the shelf.

*Gulf of Alaska - Climate and Oceanography***Tidal And Sub-Tidal Circulation In Kachemak Bay From Drifting Buoys**

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Knowledge of ocean circulation patterns is essential for understanding how marine pollutants are transported, the formation and retention of harmful algal blooms, and potential migration patterns of invasive species. The University of Alaska Fairbanks and the Kachemak Bay Research Reserve collaborated on a Coastal Community Impact Assessment Program grant to understand larval transport pathways in Kachemak Bay, Alaska using ocean drifters. During late spring to late fall, we deployed 24 drifters in Kachemak Bay that recorded GPS position at hourly or smaller intervals. Fourteen drifters were surface-tracking and ten tracked the water motion at a depth of 10 m. Following our 2013 field season, we have acquired more than 40,000 hours of drifter position data throughout Kachemak Bay, lower Cook Inlet and Shelikof Strait. The data provide detailed information about water flow and tidal energy in Kachemak Bay and vicinity. After 38-hour averaging, the non-tidal circulation emerges showing a counter-clockwise circulation around Kachemak Bay similar to Burbank (1977) but without evidence of the recirculating “gyres” sketched in his circulation map of Cook Inlet, although discussion with local mariners suggests these gyres exist. The data are being used to develop a circulation map, validate a 3D ROMS circulation model and complement previously collected data in lower Cook Inlet.

*Gulf of Alaska - Climate and Oceanography*

**Mini-Moorings Demonstrate Multiple Patterns Of Temperature And Salinity Variability At Two Inshore Sites In The Gulf Of Alaska**

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During inshore investigations that were a component of the Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP), “mini-moorings” were deployed at two inshore sites in the GOA. One mooring was placed in Salisbury Sound, on the outer coast of Southeast Alaska, and the other mooring was in Port Dick on the southern coast of the Kenai Peninsula. Each mooring included two datalogging conductivity-temperature-depth recorders (CTDs), one at 1 m depth and the other at approximately 60 m depth. Data was collected at 10-minute intervals from mid-April to early October in Salisbury Sound, and from mid-May to late October in Port Dick. Preliminary analyses of the mini-mooring data suggest that there are multiple patterns of variability in salinity and temperature at these sites: an overall seasonal trend, an oscillating pattern that appears to be linked to fortnightly variation in tidal height, and occasional disruptions that may be linked to storms or other weather events. The patterns also differed widely between the two depths, with the deeper instruments recording a much smaller range of recorded values and less variation overall. These data will be essential for understanding the seasonal dynamics of these inshore sites. In addition, offshore moorings deployed by a separate GOAIERP research group in the same areas as the inshore moorings will provide valuable information for understanding connectivity between the inshore and offshore Gulf of Alaska.

*Gulf of Alaska - Climate and Oceanography***Inshore Oceanography Of The Gulf Of Alaska**

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Through our participation in the Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP), we conducted extensive oceanography research of inshore waters of Alaska. This research focused on eleven sites on the eastern and western sides of the GOA: nine bays and two island areas that are known seabird breeding sites. The bays vary widely in their geographical extent, degree and type of freshwater influence, exposure to offshore waters, and other environmental factors. Sampling was performed during three seasons, March/April, July/August, and September/October, in 2011 and 2013. The work consisted of sampling a number of closely-spaced oceanography stations at each site, coordinated with fish surveys using multiple gears. At each oceanography station we deployed a Seabird 19+ instrument package that measures depth, temperature, salinity, turbidity, and dissolved oxygen continuously throughout the water column to within 5 meters of the seafloor. During 2013 the package also contained sensors for photosynthetically active radiation (PAR) and fluorescence, which can be used to estimate phytoplankton densities. We performed a vertical zooplankton tow using a 1m ring net; this sample will also be used to identify any ichthyoplankton encountered at inshore sites. We used a surface water sampler and a hand-deployed Niskin bottle to take water samples at 0m and 20m depth to measure nutrients and chlorophyll. Preliminary results, presented in this poster, display a high degree of spatial variability in water column characteristics within and among the inshore sites. There is also seasonal and interannual variability in these characteristics. The results will be used to describe environmental conditions for fish and other life forms, and also to study connectivity among inshore and offshore regions.

*Gulf of Alaska - Climate and Oceanography***Recent Trends In The Surface Oceanography And Lower Trophic Levels Of Prince William Sound**

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In order to track the bottom-up factors (food and environment) that may be important for herring overwintering, regular surveys of the PWS region were conducted at monthly to bimonthly frequency between late 2009 and 2012. The surveys covered the entrances to PWS, central PWS, and the four bays extensively studied by the SEA project (Eaglek, Simpson, Whale, and Zaikof Bays), and consisted of basic oceanographic and biological measurements (temperature and salinity; chlorophyll-a, nitrate, and zooplankton concentrations). The annual temperature and salinity cycles were similar among all the locations, and analysis of a 30 year time series of temperature and salinity suggests that the region is experiencing a warming and a freshening trend in the surface waters, which may have enhanced horizontal transport mechanisms (i.e. upwelling). Biological measurements showed considerable year-to-year variability, although the basic trends in biological cycling were consistent as well – there is a large spring phytoplankton bloom each year in most locations, and a less frequent autumn bloom. Zooplankton taxa broke out into several space/time groups, that corresponded with the physical and biological cycles, and appeared to be fairly consistent from year to year.

*Gulf of Alaska - Climate and Oceanography*

**A Multi-Decadal Climatology Of Currents And Hydrography For The Gulf Of Alaska**

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As part of the Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP), a 17-year (1996-2012) simulation of currents and hydrography has been completed for the entire Gulf of Alaska at 3-km horizontal resolution. Here we present climatological values from this simulation, sorted by depth and season. These are compared with a corresponding climatology of observed currents, temperature, and salinity, derived from multiyear mooring deployments. From the simulation, we generate multiyear timeseries of integrated cross-shelf fluxes through major submarine canyons of the GOA. Because they impact larval advection, these fluxes have been suggested as an important contributor to the observed interannual recruitment variability of several commercially important fish within the GOA.

*Gulf of Alaska - Climate and Oceanography*

**Potential Ocean Acidification In Prince William Sound, Alaska; Year III**

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Potential Ocean Acidification in Prince William Sound, Alaska; Year III Alta Dean Colony High School, Palmer, Alaska; USA Abstract Submission for Student Oral and Poster Competition 2014 Alaska Marine Science Symposium Potential Ocean Acidification in Prince William Sound, Alaska; Year III Abstract: I am concerned about the ecosystem and habitat that marine animals dominate. Ocean acidification starts at the base of the marine environment and continues up to the top, harming marine life. As more CO<sub>2</sub> is produced, the more oceans absorb. If one marine animal's niche is thrown off greatly, it disturbs the remaining balance of nature and can be devastating. The purpose of this experiment is to test the waters of Prince William Sound, over the course of four years, to see if there is a decrease in pH. The procedures for this experiment are as follows: •Obtain equipment needed for experiment •Arrive at the test site(s) •Test area-follow experimental procedures list •Repeat procedures at every test site •Record data •Compare new data to base line data and look for any changes I gathered a lot of different information at every test site, including; depth, barometric pressure, ocean pH, salinity, water hardness, longitude, latitude, specific gravity, tidal conditions, and the time. I compared the data I gathered from the test sites to the other test sites I tested. See charts for compared data and test sites. This is the third year of testing the waters in Prince William Sound, there was a minimal change in some areas when comparing the current data to last years base line data, all the information I have gathered makes all the difference towards helping the marine world.



*Gulf of Alaska - Climate and Oceanography***Assessing Net Community Production In A Glaciated Alaska Fjord****Stacey Reisdorph**, screisdorph@alaska.edu

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Net community production (NCP) is an important indicator of ecosystem functionality and can provide important insights into the carbon biogeochemistry of a region. Here, we estimated NCP in Glacier Bay (GLBA), by measuring the spatial and temporal variability of dissolved inorganic carbon (DIC), total alkalinity (TA) and inorganic nutrients during each season between the summer of 2011 and summer of 2012. During the summer seasons, DIC concentrations were at their lowest due to dilution from alpine and tidewater glacier melt, precipitation, and high levels of primary production. In winter months, DIC concentration rebounded due to sea-air exchange of CO<sub>2</sub> and the exchange of marine waters between GLBA and the Gulf of Alaska. Here, we calculated rates of NCP between each season within the four regions of the Bay. We found large seasonal and spatial differences in NCP with positive bay-wide rates between the summer and fall seasons in 2011 (~70 mmol C m<sup>-2</sup> d<sup>-1</sup>), as well as between the spring and summer of 2012 (~15 mmol C m<sup>-2</sup> d<sup>-1</sup>). Between fall and winter and winter and spring we observed negative NCP rates, -7 and -16 mmol C m<sup>-2</sup> d<sup>-1</sup> respectively. Integrating all of these data, we determined that during this yearlong time period total NCP across the bay was ~1.0x10<sup>10</sup> g C yr<sup>-1</sup>, with a maximum NCP of ~2.4x10<sup>8</sup> g C d<sup>-1</sup> between summer and fall 2011.

*Gulf of Alaska - Ecosystem Perspectives***A 24 Year Record Of Variability In Cover Of Intertidal Biota In Western Prince William Sound, 1989 To 2013**

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Percent cover of seaweeds, mussels and barnacles were estimated from historical and recent landscape-scale photos for up to 9 rocky mid-intertidal sites in Western Prince William Sound from 1989 to 2013. The photos were taken during annual summer surveys conducted by both the author and by volunteers. Seaweed cover (primarily *Fucus* sp.) at all sites varied greatly, from nearly 0% to nearly 100%. Multiyear periods of very high cover lasted one to three years and occurred at intervals of three to seven years. Peak and low cover did not occur in the same years at all sites but there were several multi-year periods when most sites had high cover (for example 2007 to 2009) or low cover (for example 2001 to 2005). *Fucus* cover also increased in multiyear steps at a 2000 landslide site. For mussels (*Mytilus* sp) There were also multi-year episodes of high and low mussel cover at several sites, with peak cover occurring in 1993, 1998, 2003 and 2009/10, with virtually zero cover in the intervening years. In 2007 there was a visible “set” of juvenile mussels on seaweeds at several sites, dense enough (thousands per sq m) to visibly “paint” the mid-intertidal black. This was the heaviest “set” of new mussels observed during the 24 year period. At one gravel tombolo site (Mussel Beach, Elanor Island in Upper Passage) a multi-layered bed or reef of mussels, present in 1989, completely disappeared by 1996. The mussel reef finally began “recovering” twelve years later (in 2008) but failed to develop further such that by 2013 mussels were not conspicuous at this landscape scale. This study, involving low-cost rapid site-visit landscape-scale photograph, supplemented with aerial photos, supports other rocky and gravel intertidal studies in the Gulf of Alaska suggesting there is no stable cover of mid-intertidal seaweeds and mussels but rather multi-year episodes of high and low. The photo series and data may help inspire questions about the causes and geographic scales of this variability. This poster provides supplemental data to an AMSS 2014 platform paper offered by the author and six co-authors.

*Gulf of Alaska - Ecosystem Perspectives*

**Using Automated Object-Based Image Analysis To Quantify Glacial Ice As Habitat For Harbor Seals In Tidewater Glacial Fjords In Alaska**

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Tidewater glaciers are a prominent landscape feature along the southeastern and southcentral coasts of Alaska that play a significant role in landscape and ecosystem processes. Tidewater glaciers calve large icebergs into the marine environment that then serve as an important substrate for harbor seals (*Phoca vitulina richardii*) for resting, pupping, nursing young, molting, and avoiding predators. Many of the tidewater glaciers in Alaska are retreating and may influence harbor seal populations; however, the relationship between ice availability and harbor seal abundance and distribution is poorly understood. We are investigating the relationship between ice characteristics and harbor seal distribution in Johns Hopkins Inlet in Glacier Bay National Park, Alaska using a combination of airborne remote sensing and object-based image analysis (OBIA). We present preliminary results from the use of OBIA for the automated processing of a time series of very high spatial resolution (4 cm pixels) airborne imagery (~1,250 images/survey) acquired during the pupping (June) and molting (August) periods of harbor seals from 2007 to 2012. A workflow was developed using OBIA (implemented in the eCognition software package) that automates the processing of large volumes of airborne imagery and quantifies ice characteristics in each image. Several ice-related habitat variables including percent ice cover, ice block size used by seals, angularity of ice blocks, and distance to calving edge were extracted from the imagery at three spatial scales (120 x 80m, 30 x 30m, 15 X 15m). Extracted ice characteristics will be used as covariates in statistical models that will be used to link conditions to harbor seal locations. Ultimately, understanding relationships between glacial ice availability and harbor seal distribution and abundance may provide novel perspectives on the spatial and temporal variation of harbor seals in tidewater glacial fjords.

*Gulf of Alaska - Ecosystem Perspectives*

**The Role Of Bathymetry In Sustaining Post-Bloom Production In Western Gulf Of Alaska**

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The Gulf of Alaska is a predominately downwelling regime with limited post-bloom production caused by the lack of nutrients in surface waters throughout the summer. However, satellite chlorophyll imagery suggests that post-bloom production is sustained in waters of the Kodiak Archipelago. In lieu of traditional nutrient upwelling via Ekman transport, other mechanisms of nutrient pumping must be operative off Kodiak Island to sustain summer production. We use data from hydrographic surveys, moorings, satellite-tracked drifters, and satellite imagery to examine the importance of canyons as conduits for cross-shelf advection of nutrients, heat and salt, and the roles of horizontal advection and vertical mixing in maintaining summer production southeast of Kodiak Island. Four of the major bathymetric features in the western GOA were investigated; Amatuli Trough, Chiniak Trough, Barnabas Canyon, and Shelikof Strait. Each of these features has distinct topography that influence cross-shelf flow and transport. Our results support the hypothesis that nutrient rich slope water is transported up the canyons and introduced to the upper water column by strong tidal mixing at the heads of Barnabus and Chiniak canyons, thereby sustaining post-bloom production.

*Gulf of Alaska - Ecosystem Perspectives*

**Strong Local Dynamics Of Intertidal Communities In Kachemak Bay – A Gulf Watch Program**

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Within the Kachemak Bay benthic monitoring portion of the Gulf Watch Program, replicate intertidal sites are being monitored annually for benthic community composition, mussel (*Mytilus trossulus*) size-frequency distribution, clam composition, and seagrass abundance. For all these components of the intertidal communities we observed strong local differences among the study sites in the bay. For example, significant differences existed in seagrass abundance and rocky intertidal community composition among sites. The clam species composition was locally dominated by different species at the various sites. Strong recruitment events of mussels were observed for some but not other sites in 2013. These results indicate that site-specific dynamics are sufficiently strong to significantly influence intertidal community structure. These site-specific conditions may be related to environmental controls as well as local biological interactions. Site-specific dynamics are an important constraint within the goal of large-scale monitoring that needs to be addressed appropriately with sufficient replication as well as local monitoring of environmental conditions.

*Gulf of Alaska - Ecosystem Perspectives***Evaluating Environmental Contamination From Abandoned Mine Sites On Prince Of Wales Island, Alaska**Kristin Brown, [klbrown13@alaska.edu](mailto:klbrown13@alaska.edu)Anne Palmieri, [annemarie.palmieri@alaska.gov](mailto:annemarie.palmieri@alaska.gov)

According to the United States Geological Survey, there are over 7,600 mines, prospects, and mineral occurrences located within the State of Alaska. Most of these mines and prospects were actively used in the early to mid-20th century and have now been abandoned. Conditions at these mines vary widely in the extent of contamination that is present, from little to no impacts to high levels of contamination that pose serious risks to human health, the environment, and ecological systems. The purpose of this pilot study project was two-fold: 1) to determine if elevated concentrations of metals and mercury are present in biota, surface sediment, or adjacent freshwaters at a set of three abandoned mine sites on Prince of Wales Island; and 2) to test the feasibility of implementing a full-fledged site discovery program to identify and assess impacts from abandoned mine sites. The Copper Queen, Rush & Brown, and Hadley mines on Kasaan Peninsula were sampled August 26-28, 2013. Samples collected at the Copper Queen mine included one water sample (and a control), one sediment sample (and a duplicate), and blue mussels (*Mytilus edulis*) from two beach locations; the substrate was too rocky for within-sediment biota. At the Rush & Brown mine, samples included four water samples (plus a control) and six sediment samples; lack of a marine shore limited biota sampling. Hadley mine samples included three water, seven sediment (plus a duplicate), and biota samples from seven beach locations, all of which consisted of blue mussels except one location which consisted of a single cockle clam (*Clinocardium nuttalli*). The cockle was found at the surface, and little to no evidence of any species of clam was found within the beach sediment. All samples are analyzed for total mercury and metals (including antimony, arsenic, cadmium, chromium, copper, and lead) using EPA Methods 6020 (metals), 7473 (mercury), and 200.8 (for water samples) on an Inductively Coupled Plasma Mass Spectrometry. The results of this pilot effort will provide insight for evaluating potential issues of concern at abandoned mine sites, including potential risk to human health and ecological systems from metals and mercury.

*Gulf of Alaska - Ecosystem Perspectives***Hydrogen And Carbon Isotopes Trace Glacier Runoff Through Coastal Marine Food Webs In The Gulf Of Alaska**

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Freshwater input maintains the water density gradient that drives the Alaska Coastal Current and influences marine productivity in coastal areas of the Gulf of Alaska. Nearly half of the freshwater discharge into the Gulf of Alaska originates from glacier melt. Dissolved organic matter in glacial rivers differs from that of other river types because the ancient carbon it contains is more bioavailable to marine microorganisms. To demonstrate linkages between terrestrial and marine ecosystems, we are using stable and radio isotopes to estimate the relative contribution of glacially-derived organic matter and freshwater to marine food webs. During summers of 2011-2013, we sampled dissolved inorganic and particulate organic matter, zooplankton, forage fish and seabirds near tidewater glaciers in Yakutat Bay, Icy Bay, and Prince William Sound, Alaska. We collected control samples with no glacial influence in the western Aleutians. We also collected water samples to measure the extent of mixing and infiltration of glacial melt water in the marine system. We hypothesize that  $\delta^2\text{H}$ ,  $\delta^{13}\text{C}$  values and radiocarbon ( $^{14}\text{C}$ ) ages from lower trophic marine organisms will permit us to trace glacier-derived organic matter and freshwater in marine food webs owing to the markedly different isotope ratios between glacio-terrestrial versus marine hydrogen and carbon sources. We also expect  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  isoscape mapping to clearly show the pattern of freshwater mixing into the marine environments in exposed versus protected coastal areas. Given the predicted impact of global warming on glacier thinning and retreat along the Gulf of Alaska this work will enhance our understanding of how changes in freshwater discharge from glaciers may influence coastal marine ecosystems.

*Gulf of Alaska - Ecosystem Perspectives*

**Effects Of Glacial Discharge On Recruitment And Succession On Coastal Rock Communities**

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Melting of Arctic and Subarctic glaciers carries sediment-laden freshwater to coastal habitats. Glacial discharge can structure benthic communities through multiple mechanisms that may restrict settlement and alter succession. The goal of this study is to determine the influence of glacial discharge on recruitment and succession in coastal rock communities. Recruitment and succession is being monitored at six sites along a glacial discharge gradient by estimating benthic algal and invertebrate cover on cleared rocks at 10 meter depth from March 2013 to June 2014. Sedimentation rate, temperature, salinity, light, and nutrient concentration are environmental factors directly influenced by glacial discharge that are being monitored at each site. Additionally, wave exposure, substrate rugosity, nearby adult kelp density, and invertebrate grazers and predators are being analyzed to determine correlations between these drivers not directly related to glacial discharge and algal and invertebrate initial and post-recruitment densities. Initial data from March 2013 to September 2013, indicate that the composition of early the recruits on the cleared rocks was distinct between the outer and inner bay, with barnacles dominating the available space in the inner bay and almost no barnacle recruitment in the outer bay, but some recruitment of spirorbid worms. Environmental variables are different across sites, although differences do not follow the expected glacial discharge gradient across the bay. Of the non-glacial discharge factors, abundance of adult kelp and mobile grazers appears the most different across sites. Next steps for this project are continued monitoring of biological and environmental data and data analysis.



*Gulf of Alaska - Ecosystem Perspectives***Monitoring Interannual Variability In Marine Mammal And Prey Distribution Near Kodiak Island, Alaska****Bree Witteveen**, bree.witteveen@alaska.edu

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Variability is a constant component of the Kodiak marine environment. Regional, seasonal and interannual changes in diets of apex predators and prey availability have been noted during studies conducted as a part of the Gulf Apex Predator prey (GAP) project. Variability GAP has documented in the diet and distribution of opportunistic marine mammals are reflective of changes in the distribution and abundance of their prey, which in turn suggests changes in the prey-specific suitability of marine conditions. Although high degrees of interannual variability in the distribution of apex predators have been documented, GAP has lacked a means of measuring and comparing conditions associated with changes to their prey fields. In response, GAP developed three “Variability Index Sites” (Marmot, Uganik and Shuyak, respectively) in Kodiak waters that have historically supported large aggregations of fish, birds and marine mammals. Within each site, systematic sampling grids were established to allow for repeated measurement of physical and biological parameters, including water temperature and salinity profiles, proportional backscatter of fish and zooplankton, species-specific whale counts, and zooplankton composition. Surveys of Index Sites began in 2012 and were repeated in 2013. During surveys, we completed 243 nmi of acoustic trackline and 67 CTD casts in each year. Preliminary analysis showed that in 2012 fin whales were associated with moderate levels of zooplankton backscatter at the Uganik Index Site, while humpback whales were associated with very dense zooplankton backscatter at the Marmot Index Site and forage fish backscatter, likely capelin, at the Shuyak Index Site. Conditions in 2013 were considerably different than in 2012. Most notable was the paucity of zooplankton backscatter at each of the Index Sites. The only significant backscatter in 2013 was observed at the Shuyak Index Site and was attributed to forage fish, likely capelin again. The Shuyak Index site was also the only site in which whales, primarily humpback whales, were sighted during 2013 surveys. While preliminary, these results highlight the importance of replicate annual sampling to provide a quantitative means of documenting changes in local conditions.

*Gulf of Alaska - Ecosystem Perspectives***Gene Transcript Profiles In Mussels (*Mytilus Trossulus*) From Prince William Sound, Alaska, 2012 & 2013, As Indicators Of Nearshore Ecosystem Health**

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Nearshore marine ecosystems face unprecedented challenges from climate and landscape change at global and regional scales, with anticipated impacts from both adjacent lands and oceans. From the ocean, impacts include changes to pelagic and benthic productivity, altered currents and upwelling patterns, sea level rise, acidification, and warming. Our understanding of the physical processes resulting from climate change is advancing due to accumulating data and refined models, but our understanding of the implications for biological systems remains rudimentary. There is an urgent need for identification of subtle effects of climate change at the cellular and molecular level that could be used as an early warning sign and predictor of damaging longer-term impacts. The earliest observable signs of physiological impairment are altered levels of gene transcripts, evident prior to clinical manifestation. To evaluate ecosystem health in the Gulf of Alaska, we have initiated studies of gene transcription in *Mytilus trossulus*, a marine bivalve, as an indicator and predictor of ocean acidification, temperature change, pollutant levels, and altered pathogen presence that may be associated with climate change. Marine mussels are widely used as screening tools for the presence of pollutants, and use of their physiological condition as a predictive and diagnostic tool is becoming more common. We have developed a diagnostic panel of 13 genes, representing different physiological systems that typically respond to changes in ocean acidity, oxygen content, temperature, contaminants, and pathogen assemblages, for use with *M. trossulus* to assess the health and climate change impacts of nearshore ecosystems. In 2012 and 2013, we collected mussels from 5 sites in western Prince William Sound, and analyzed mRNA levels in adductor muscle from 3 mussels at each site. In 2013, compared to 2012, mussels showed increased detoxification and thermal stress responses, and decreased calcium binding, O<sub>2</sub> homeostasis, and antimicrobial responses. This study is integrated with the ongoing Gulf Watch Alaska project, which includes a major nearshore ecosystem component, and thus will benefit from related information collected at the study sites, including densities and size distributions of mussels, temperature and contaminant data.

*Gulf of Alaska - Ecosystem Perspectives*

**Extent Of Paralytic Shellfish Poisoning-Tainted (PSP) Sandlance Along The Northeastern Pacific Ocean Coast.**

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Sandlance are implicated in obtaining high levels of PSP likely from feeding on the organism that makes the PSP toxins, a marine dinoflagellate, *Alexandrium* sp. The transfer of the PSP toxin to marine predators may be common along the North Pacific coast and may be impacting marine predator populations (Wright 2011a). Hypotheses to consider when analyzing the data are: H1: Marine predator population numbers may fluctuate in response to consumption of PSP-tainted sandlance. H2: PSP-tainted sandlance occur in much of the Gulf of Alaska and Aleutian Islands' coastal waters.

*Gulf of Alaska - Ecosystem Perspectives*

**Shorezone Imagery And Mapping In Alaska And In The Pacific Northwest**

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ShoreZone is a coastal marine habitat mapping system, in which spatially referenced aerial imagery is collected specifically for classification. The resulting dataset includes imagery with mapped geomorphic and biological attributes in a searchable geospatial dataset. The imagery provides a useful baseline and visual reference. The mapped features include: shoreline morphology, substrates, and biotic resources such as eelgrass, canopy kelps, salt marshes and other habitat descriptors. There are many applications for this data including: oil spill contingency planning, habitat research, and coastal resource evaluations. Approximately 108,095 km of ShoreZone imagery exists for the Pacific Northwest coastline including the entire shoreline of Oregon (1,795 km), Washington (4,933 km), British Columbia (37,619 km), and 63,748 km of the Alaskan coastline (~80%). The Alaska ShoreZone imaging and mapping project is on-going with 76% of the coastal imagery mapped or with mapping in progress and ~ 20% (15,500 km) of the coastline remaining to be imaged. The Alaska imagery can be viewed online at <http://alaskafisheries.noaa.gov/shorezone/>. The Alaska ShoreZone program is built on a foundation of multiple funding and contributing partners, including state and federal governmental agencies, nonprofit organizations, and private industry, as well as resource managers, scientists, and spatial data specialists. The multi-organization program provides a framework to build on and supports a contiguous, integrated coastal resource database that extends from Southeast Alaska through the Gulf of Alaska, the Alaska Peninsula, Bristol Bay, and northwards to Kotzebue Sound, and the Chukchi and Beaufort Seas. The program goal is to have all of the Alaskan shoreline imaged and mapped using the ShoreZone protocol and to make this data web accessible. The partnership is actively seeking additional partners to help accomplish this goal.

*Gulf of Alaska - Ecosystem Perspectives***Slightly Weathered Oil From The Exxon Valdez Spill Persists On Rocky Gulf Of Alaska Shores After 23 Years**

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Twenty-three years after the 1989 Exxon Valdez spill deposited oil mousse on rocky shores of national parks in the Gulf of Alaska, we reexamined our long-term study sites. We have been investigating the relationship of boulder stability to oil persistence, changes in surface and subsurface oiling over time, and the degree to which the oil has weathered. Repeat visits show that oil persistence is highly dependent on the stability of the boulder armors, some of which have remained intact for 20+ years. Surface oiling continues to decline and is now at very low levels while subsurface oiling continues relatively unchanged at 4 of the 6 sites. New in 2011 and 2012 was the deployment of passive samplers at two sites; these revealed that some oil constituents are moving into the water. For the first time since 1989, there was no apparent oiling at the most distant site from the spill origin; the extent of oiling was reduced at another site. At the four remaining sites, the oil is only slightly weathered, although there are indications of microbial degradation at one of these sites. Comprehensive two-dimensional gas chromatographic (GC x GC) analyses have provided an order of magnitude increase in the discrimination of compounds found in the oil as compared to traditional GC analysis; especially interesting is the illumination of biomarker abundance in the oil. Since biomarkers are among the most persistent oil constituents, they are useful for definitive identification of oil source. Thin-layer chromatography--flame ionization detection analyses indicate no significant accumulation of recalcitrant oxygenated hydrocarbons at four of the sites, consistent with only minor oil weathering.

*Gulf of Alaska - Ecosystem Perspectives*

**Red Flags Or Red Herrings Revisited: Using Ecosystem Indicators To Track Ecosystem Status In The Gulf Of Alaska**

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NOAA compiles and synthesizes information about the Alaska marine ecosystem annually into an ecosystem considerations report primarily for the North Pacific Fisheries Management Council, but also the scientific community and the public. The goal of this report is to provide stronger links between ecosystem research and fishery management and to spur new understanding of the connections between ecosystem components. There are more than one hundred time series of physical and biological indicators that are tracked and updated, many annually. The status and trends of these indicators are monitored for early signals of ecosystem change that may have management implications. Beginning in fall 2011, the status of a suite of ecosystem indicators cumulatively suggested that anomalous conditions had occurred in the Gulf of Alaska that year. The first indications were noted in upper trophic organisms (seabirds and Pacific halibut) that experienced reproductive failures and potential nutrient deficiencies, respectively. However, evidence suggested that upper trophic organisms were influenced by bottom-up forcing changes that negatively influenced productivity at the lower trophic level. In this presentation, we revisit this chain of events to see if there were similar connections detectable in other years. The same suite of indicators suggests that bottom-up forcing was not as limiting in 2012 and 2013. We conclude that: (1) synthesis of indicators' status across multiple trophic levels can reveal broad-scale changes in the environment that may have important biological and management implications, and (2) potential mechanisms underlying these broad-scale changes may be useful for making predictions of future ecosystem states.

*Gulf of Alaska - Fish and Fish Habitat***Adjective Or Adverb 2**

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Eulachon, *Thaleichthys pacificus*, is an anadromous smelt of the northeastern Pacific Ocean, spawning in coastal rivers that range from northern California to southwest Alaska. In the southern portion of its geographic range, low abundance of eulachon returns has led to federal protection of populations in California, Oregon, Washington, and British Columbia. The cause and extent of these apparent declines remain unidentified, as eulachon are poorly understood and data are limited. In the Chilkat and Chilkoot rivers of Southeast Alaska, eulachon runs have been locally perceived as low in abundance in some years. Indigenous and local residents of the nearby communities harvest eulachon from the Chilkat and Chilkoot rivers, utilizing them for a variety of consumptive and cultural purposes. Spawning and pre-spawning eulachon also attract aggregations of predators near the mouths of rivers. Local observations suggest that eulachon runs of the Chilkat and Chilkoot rivers vary in timing and abundance between years and location, with causes of variation unknown. To address this variation, data collected from historical documents, scientific studies, and local and traditional knowledge interviews will be synthesized to construct trends in eulachon run timing and abundance of the Chilkat and Chilkoot rivers. Run timing will be constructed as a time series, and relative abundance will be estimated through the use of fuzzy logic analysis to combine qualitative and quantitative data. Environmental data will be used in correlation tests and generalized linear modeling to examine relationships between environmental variables and eulachon run timing and abundances. I will present preliminary results on past and present characteristics of eulachon runs of the Chilkat and Chilkoot rivers.

*Gulf of Alaska - Fish and Fish Habitat***Estimation Of The Relationship Between Growth And Consumption Rates In Juvenile Pacific Cod (*Gadus Macrocephalus*) At 4 Temperature Treatments**

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Pacific cod are generalist upper trophic level predators in the Gulf of Alaska (GOA), and are an important predator on other commercially important species. We conducted a feeding study to understand the relationship between temperature, ration, and growth. Efficient management of this species requires knowledge of how these fish adapt to changing environmental conditions, with a focus on how growth and condition are affected by changes in temperature and diet. This is especially important in the context of the GOA, given the incomplete understanding of how climate, fishing, and food web dynamics interact in this region. Since growth and condition of juveniles can determine recruitment into the population, this study focused on rations that maximize growth (Copt), and maximal consumption rates (Cmax) of age 1+ Pacific cod held over 4 temperature treatments (4°C, 8°C, 12°C, and 16°C) and 3 ration levels (unlimited (Cmax) ration, medium ration, and low ration). We also compared cellular nucleic acid (RNA/DNA) ratios, an instantaneous growth index. In all 4 temperature treatments, similar growth rate/consumption trends were observed, where fish at medium and low rations had higher growth rates relative to fish at Cmax rations. Parabolic growth curves generated from this study suggested Copt for fish at different temperatures, which were then confirmed in a secondary feeding study. While Pacific cod are capable of high consumption rates, higher food consumption appears to negatively affect digestive ability, assimilation efficiency, and nutrient utilization. RNA/DNA was clearly correlated with growth rates at temperatures more relevant to that observed in the GOA (4°C and 8°C), but this relationship did not hold at higher temperatures. Copt might be more relevant than Cmax in examining growth/consumption relationships in Pacific cod. Pacific cod are voracious feeders, and depending on temperature, experience maximum growth at rations (Copt) ranging from 15% to over 30% of their body weight/day. In contrast, rations that maximize growth of similarly aged walleye pollock at same temperature treatments ranged from 12%-17%/day. These data indicate Pacific cod consume proportionately more biomass than other species in the GOA.



*Gulf of Alaska - Fish and Fish Habitat*

**Quantifying *Ichthyophonus Hoferi* Prevalence And Intensity In Pacific Halibut (*Hippoglossus Stenolepis*) In Cook Inlet, Alaska**

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*Ichthyophonus hoferi*, a non-specific fungus-like protozoan fish parasite, has caused epizootic events among economically important fish stocks including herring and salmon and can result in reduced growth, stamina, and overall fish health. Recently *Ichthyophonus* was detected in Pacific Halibut (*Hippoglossus stenolepis*) in Cook Inlet, Prince William Sound, Gulf of Alaska, and the Bering Sea. To date no studies have investigated the prevalence, intensity or associated physiological impacts of *Ichthyophonus* on Pacific halibut. During the summers of 2012 and 2013 we sampled sex, length, age, diet composition, heart, spleen, liver, and kidney tissues from 524 halibut landed by the Homer sport-charter fishery. *Ichthyophonus* prevalence was determined by MEM culture and intensity (spores/ gram) determined using Pepsin digestion. In 2012, 29% of the fish sampled had *Ichthyophonus*; 32% in 2013. We found no evidence of the parasite in liver, spleen or kidney tissues and there was no difference in prevalence between males and females. Preliminary Pepsin digestion analysis (13 fish assessed to date) indicates a wide range of intensity among sick fish with 17 to 582 *Ichthyophonus* spores per gram of heart tissue. Analyses to determine the diet composition of sick fish using gut contents and stable isotopes are ongoing.

*Gulf of Alaska - Fish and Fish Habitat*

**Exploring Meso- And Submesoscale Eddies Regulating Early Life Stages Of Walleye Pollock Survival In The Gulf Of Alaska**

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Walleye Pollock, an important fishery in the Gulf of Alaska, is characterized by spatially disaggregated spawning and nursery habitats. Historically, a large part of the egg production has been associated with Shelikof Strait and advected southwest along the Alaska Peninsula, where by summer and through early fall, juveniles arrive at the Shumagin Islands nursery area. The effect of meso- and submesoscale eddies on connectivity, transport and survival of young pollock is not well understood. An individually based model (IBM) of young walleye pollock coupled with a Nutrient/Phytoplankton/Zooplankton model and a Regional Ocean Modeling System physical model was used to explore the impact of eddies on survival during the young pollock life cycle. Eddies were identified, filtered by size, and followed in time from model simulations. Eddy statistics were extracted from three model years and compared with satellite observations (validation purposes) and recruitment indices. Preliminary analysis showed that simulated eddy statistics were consistent with observations, and in good agreement with recruitment estimates for the years analyzed. This study is being developed under the framework of Gulf of Alaska Integrated Ecosystem Program.

*Gulf of Alaska - Fish and Fish Habitat*

**Mapping Tanner Crab Habitat In The Kodiak Area Of The Gulf Of Alaska**

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Alaska Department of Fish and Game (ADF&G) manages commercial fisheries for Tanner crabs *Chionoecetes bairdi* in the Gulf of Alaska (GOA) and conducts annual bottom trawl surveys to assess the populations and provide data to set harvest limits. Bottom trawling is limited to trawlable habitat that comprises only a proportion of the total survey area. The current practice of expanding Tanner crab densities from trawlable habitat to large areas of unknown habitat can potentially create bias in overall population estimates; this is critical because state regulations require that population estimates exceed a lower threshold before opening Tanner crab fisheries. For a benthic species like Tanner crab, understanding the relationships between habitat and abundance is essential for extrapolating population density estimates to larger scales. The goal of this project is to map and describe important Tanner crab habitat northeast of Kodiak Island in the GOA. For the first time, we used WASSP multibeam sonar and a towed benthic imaging system (CamSled) to deliver full-coverage maps of bathymetry and seafloor acoustic backscatter and to provide both classified substrates and biological observations for Tanner crab habitat. Tanner crabs have preferred habitats and are associated with specific bottom characteristics that can be recognized in data collected by a multibeam sonar system: substrate, biota, and geomorphologic characteristics (depth, hardness, slope, rugosity). This information will be used to increase understanding of the spatial distribution of Tanner crab and their habitat and will aid in interpretation of stock assessment data.

*Gulf of Alaska - Fish and Fish Habitat*

**Discard Mortality Studies For The Giant Pacific Octopus, *Enteroctopus Dofleini*, In Alaska Waters**

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The giant Pacific octopus (*Enteroctopus dofleini*) is the most abundant octopus species found on the continental shelf of Alaska and it dominates the commercial catch of octopus within Alaska waters. There is no fishery directly targeting octopus, but they are taken as bycatch in trawl, longline, and pot fisheries throughout Alaska, with the majority of catch coming from Pacific cod (*Gadus macrocephalus*) pot fisheries. Recent changes to management of octopus within this region necessitate a more complete understanding of the fate of octopus captured and released during fishing operations. On-board fisheries observers collected data about octopus weight, sex, and condition at capture in a variety of Alaska groundfish fisheries from 2006-2011. A study aboard a commercial pot-fishing vessel in the southeast Bering Sea in January 2013 examined short-term delayed mortality of octopus held in running seawater tanks. A long-term delayed discard mortality study will occur at the Kodiak Laboratory seawater facility during 2013 and 2014 with octopus captured in Gulf of Alaska pot fishing operations. Results from the immediate and short-term delayed mortality studies indicate octopus are often released in excellent condition and are likely to experience low delayed mortality, especially in the pot fisheries in which they are most commonly captured. This research will aid in the management of octopus within this region.

*Gulf of Alaska - Fish and Fish Habitat***Trophic Relationships Among Juvenile Salmon During A 16-Year Time Series Of Climate Variability In Southeast Alaska**

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We examined annual differences in diet composition, energetic condition, size, and temperature associated with juvenile pink (*Oncorhynchus gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), and coho (*O. kisutch*) salmon in marine waters of Icy Strait, a primary migration corridor in Southeast Alaska, in July 1997-2012. Salmon were sampled from a single location (using  $n \leq 10$  fish per species per year) while en route to the Gulf of Alaska. During this 16-year period of climate change, the Icy Strait Temperature Index (ISTI) varied from 8.3 to 10.3 °C annually (mean 9.3 °C). Overall, juvenile pink, chum, and sockeye salmon were planktivorous, whereas juvenile coho salmon consumed a mixed diet of crab larvae and fish larvae. Diets differed between cold and warm years for the planktivorous species, but not for juvenile coho salmon. In colder than average years, diets of pink, chum, and sockeye salmon were homogeneous and consisted mainly of oikopleurans; in warmer than average years, the diets were more diverse, and included oikopleuran, euphausiid, hyperiid, and calanoid copepod prey that were partitioned among the species. Size of all juvenile salmon was smaller in cold years than in warm years, but energetic condition did not differ. The annual pattern of energetic condition was similar for the planktivorous salmon species, and was more variable for juvenile coho salmon. However, chum salmon energetic condition was consistently lower than for pink, sockeye, and coho salmon, which could be associated with greater predation on low-energy oikopleurans. Although long-term climate effects were reflected in juvenile salmon diet quality and size in July, lack of climate effect on energetic condition could result from prior conditions experienced by the fish.

*Gulf of Alaska - Fish and Fish Habitat***Seasonal Tradeoffs In Growth Vs. Energy Storage In Juvenile Pacific Herring From Prince William Sound**

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Winter survival of young-of-the-year (YOY) herring is highly variable and a major determinant of year-class strength. YOY herring appear to undergo a seasonal size-dependent shift in energy allocation strategy, with fish below a critical size in autumn continuing to favor growth while larger individuals store more lipids. The seasonal timing of changes in growth and lipid storage is important for modeling winter mortality and provides a context for interpreting fish condition data from biannual monitoring efforts. Stored lipids and growth also may vary spatially due to local habitat differences, and contribute to variable herring survival among bays in Prince William Sound (PWS). For this study, a component of the PWS Herring Research and Monitoring program, we investigated seasonal trends in YOY herring growth, energy storage, and diet from autumn 2011 through summer 2012. Mean RNA/DNA declined 71.6% from September to November, remained low through March, and increased nearly four-fold again by May. By March, herring with lipid stores below 2% had higher stomach fullness, indicating these individuals were compelled to take on greater predation risk by foraging to avoid starvation. Small herring will reach this point sooner in winter than large herring due to their lower lipid stores, limited ability to forage on high-energy prey, and rapid energy consumption. In comparison, herring that are large, fast-growing, and have high lipid levels in autumn appear best positioned to survive winter. Autumn growth and lipid levels were highest in Whale Bay, where diets consisted largely of euphausiids. Differences in prey quality among bays, and the link to herring growth and energy stores, show the importance of localized bottom-up processes in determining winter survival.

*Gulf of Alaska - Fish and Fish Habitat*

**Seasonal Use Of Inshore And Offshore By Age-0 Walleye Pollock And Pacific Cod  
In The Eastern And Central Gulf Of Alaska**

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Coordinated sampling of the coastal Gulf of Alaska (GOA) conducted as part of the GOA Project has provided new insight into how age-0 walleye pollock and Pacific cod use nearshore, inshore, and offshore habitat. Interannual, regional, and seasonal differences in habitat use are reported and contrasted with biophysical conditions. Observational data reported will be compared to habitat quality metrics and used to infer interannual patterns in abundance and distribution to age-1 year class recruitment.

*Gulf of Alaska - Fish and Fish Habitat***Effects Of Polystyrene Ingestion On Juvenile Pink Salmon (*Oncorhynchus Gorbuscha*)**

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Recent surveys in Alaska indicate a massive increase in the amount of polystyrene in marine ecosystems. Our surveys of Alaskan beaches indicate a >1000-fold increase in the amount of polystyrene as well as multiple anecdotes of small plastics in zooplankton tows. Ingestion of polystyrene could negatively impact growth in juvenile pink salmon. Polystyrene is a relatively inert polymer formed from aromatic hydrocarbons. However, it is non-polar and can sequester dissolved hydrophobic compounds such as organochlorines and polynuclear aromatic compounds. Moreover, tidal action can erode larger polystyrene debris into microplastics, particles that may be attractive to fine scale grazers such as larval and juvenile fish. To study the potential impacts of polystyrene ingestion, we fed juvenile pink salmon (average length 46.5mm) a commercially available diet, a commercial diet mixed with polystyrene (1:1 ratio by volume with particle diameter 0.3-0.6mm), and a commercial diet containing 0.08% ANS crude oil. Fish were fed thrice daily for 5 weeks. We measured a cellular instantaneous growth index, nucleic acid (RNA/DNA) ratios, to better elucidate changes in growth rates over shorter time scales. A hydrocarbon stressor index, Cytochrome P350 (CYP1A1), was used to provide an accurate biomarker for liver toxicity. Total plastic ingested per fish was also determined. No difference in mortality rates between the control tanks and treatment tanks containing polystyrene was observed. Similar growth rates were observed in all three treatments, suggesting that the ingestion of polystyrene with food does not negatively affect growth or foraging ability in juvenile pink salmon, at least in the short-term.



*Gulf of Alaska - Fish and Fish Habitat***They Grow Up So Fast: Comparing Growth Strategies In Bering Sea And Gulf Of Alaska Young Of The Year Gadids**

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Pacific cod (*Gadus macrocephalus*) and walleye pollock (*Theragra chalcogramma*) represent two of the largest commercial fisheries in the United States and are important groundfish in both the eastern Bering Sea (EBS) and Gulf of Alaska (GOA) ecosystems. Young of the year (YOY) cod and pollock need to allocate energy for growth and lipid storage to maximize their overwinter survival. This study reviews the energy densities, dry weights, and diets of YOY cod and pollock from the EBS and GOA to better understand how energy allocation strategies vary between species and large marine ecosystems (LMEs). Fish were collected in August, 2012 during the Bering-Aleutian Salmon International Survey (BASIS) and Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP) summer surveys. Energy densities, as determined by bomb calorimetry, and dry weight were used as a proxies for body condition. For cod and pollock of a given length, GOA fish were significantly heavier than EBS fish (ANOVA,  $p < 0.001$ ) suggesting conditions in the GOA favor higher rates of gaining mass for both species. Pollock were longer in the EBS than the GOA (t-test,  $p < 0.001$ ) with average energy densities of  $22.39 \pm 0.14$  kJ/g [mean  $\pm$  SE] and  $22.03 \pm 0.17$  kJ/g, respectively. At any given length, pollock energy densities were not significantly different between the two basins (ANOVA,  $p = 0.969$ ). Pacific cod had greater energy densities in the GOA ( $21.33 \pm 0.14$  kJ/g) compared to the EBS ( $19.98 \pm 0.11$  kJ/g) (ANOVA,  $p < 0.001$ ), though the average length of EBS cod was greater than in the GOA (t-test,  $p < 0.001$ ). Greater energy densities in GOA cod indicate proportionately higher lipid levels in the GOA cod and suggest a higher survival potential than EBS cod. Diet data were collected and will be compared between species and LMEs to determine if differences in energy density and dry weights relate to diet quality. Observed differences in energy allocation strategies between species and across LMEs provide valuable insights into the mechanisms affecting pre-winter condition, which can in turn be used to estimate gadid survival to age-1.

*Arctic - Fish and Fish Habitat***Salmon Blood Plasma To Control Texture Softening Of Surimi And Fresh Salmon Fillets**

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Pacific whiting contains high amounts protease enzymes, which soften the texture of the fish, leading to poor quality Pacific whiting surimi (PWS). These same enzymes also contribute to the softening of salmon fillets. Blood plasma contains several proteins, which inhibit these enzymes. Previously, bovine blood plasma was used in the production of PWS. However, this practice has been discontinued due to public fear of Bovine Spongiform Encephalopathy. Salmon blood, a significant byproduct of salmon production that currently goes into the waste stream and contributes to environmental contamination, has also been found to contain these inhibitors. The objective of this study is to investigate the effectiveness of salmon blood plasma (SBP) on improving the texture of both PWS and salmon fillets. Chinook salmon blood collected at various hatcheries near Astoria, Oregon and centrifuged to obtain SBP will be either freeze-dried or fractionated using ammonium sulfate and assayed to find protease inhibitor fractions (PIF). Freeze dried SBP and PIF will be mixed with PWS and salmon fillets at concentrations of 1, 2, 3, and 4% and evaluated for the inhibition of enzymatic autolysis. PWS containing these same concentrations of SBP or PIF will be cooked at 90°C for 30 minutes with or without preincubation either at 25°C for 3 hours or 55°C for 30 minutes. PWS gel will also be cooked ohmically 90°C in 30 seconds. Resulting gels will be evaluated using a texture analyzer and compared to a control. Salmon fillets injected with SBP containing solutions of varying concentration will be cooked at 90°C for 30 minutes with or without pre incubation at 55°C for 30 minutes. The texture of the fillets will be evaluated using a Warner-Bratzler shear attached to TA texture analyzer and compared to a control. Preliminary results show that SBP added to PWS at a level of 2% significantly improved gel texture of PWS. SBP (1%) also significantly inhibited enzymatic autolysis in PWS. SBP was shown to be as effective as dried egg whites (current industry standard) at these levels. These results show that SBP can be used as a valuable byproduct of the salmon processing industry.

*Gulf of Alaska - Fish and Fish Habitat***Building Early Ontogeny Pelagic Exposure Profiles For Gulf Of Alaska Integrated Ecosystem Research Program Focal Species, Based On Historical Ichthyoplankton Data.**

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The Lower Trophic Level component of the Gulf of Alaska Integrated Ecosystem Research Project (GOAIERP) seeks to determine how the physical oceanographic environment influences plankton communities, and subsequently early life stage abundance, distribution and survival to recruitment of the focal fish species; Pacific cod, walleye pollock, Pacific ocean perch, sablefish and arrowtooth flounder. As part of this endeavor, a retrospective analysis has been undertaken of four decades of historical ichthyoplankton data collected primarily in the central and western GOA by the Recruitment Processes Program of NOAA's Alaska Fisheries Science Center. Spatial, seasonal, and interannual patterns of variation in abundance and lengths of the early ontogenetic stages of the five key species have been integrated into the construction of individual pelagic exposure profiles for these species, and have been incorporated into the development of Individual Based Models for each species by the Modeling component of GOAIERP. The pelagic exposure profiles synthesize the following ecological information: 1) Temporal patterns in abundance of eggs and larvae that characterize seasonal exposure to the pelagic environment, and interannual variation that may reflect response to long-term environmental forcing; 2) Spatial patterns that identify horizontal and vertical extent of egg and larval distributions, delineate areas of primary larval habitat, and illuminate egg and larval drift pathways; 3) Differences in early life history characteristics between the eastern GOA and the central to western GOA; 4) Similarities and synchronies among the GOAIERP species and other prominent GOA species in terms of early life history environmental exposure and response patterns; and 5) Identification of remaining gaps in information needed for determining early life history aspects of recruitment processes. Five posters are presented summarizing these profiles for each of the focal species (although data on unidentified rockfish larvae – *Sebastes spp.* – are presented for Pacific Ocean perch as larvae of this species are not distinguishable morphologically from other rockfish species).

*Gulf of Alaska - Fish and Fish Habitat***Distribution And Abundance Of Juvenile Fishes Throughout The Nearshore Gulf Of Alaska**

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As part of the Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP), we sampled fish in nearshore areas within nine bays in the eastern and western sides of the GOA. The bays varied widely in their geographical extent, predominant habitats, and exposure to offshore waters. In 2011 and 2013, sampling was conducted during April, July, and September in the eastern GOA and May, August, and October in the western GOA. We used a 16 ft inflatable boat to deploy a ~15m diameter purse seine, pursing and retrieving the net by hand. Sampling was limited to depths of 20 ft. and shallower to ensure that the lower edge of the net contacted the bottom. Sampling sites were also chosen based on the presence of vegetative physical structure attached to the seafloor (e.g. eelgrass, Laminaria kelp) as identified using a skiff-mounted echosounder and visual observation. At each sampling site we measured temperature and salinity, and when possible we deployed an underwater video camera to verify habitat type. Results presented in this poster are preliminary, as analysis of the data is ongoing. The species composition of and abundance in catches varied within and among the sites, as well as with season and year. For all areas, species composition changed more dramatically from spring to summer than from summer to fall. In some areas, 2013 catches were similar to 2011; in others catches were entirely different. Age-zero Pacific cod and pollock were less abundant in 2013 and 2011, and spatial patterns of abundance varies between the two years. While some species appeared to have a strong preference for one type of vegetative habitat, the distribution of juvenile fishes seemed to be less dependent on small-scale habitat features and more influenced by large-scale geographic patterns within bays. Abundance of fishes was generally greater in the western GOA. The results of these studies will be used to investigate fish ecology within bays and will also be combined with offshore studies conducted simultaneously to understand connectivity between inshore and offshore areas of the GOA.

*Gulf of Alaska - Fish and Fish Habitat***Size-At-Age And Diet Composition Of Pacific Halibut (*Hippoglossus Stenolepis*) In Cook Inlet, Alaska**

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Declining Pacific halibut (*Hippoglossus stenolepis*) size-at-age in South Central Alaskan waters (regulatory area 3-A) remains unexplained. In order to improve stock assessments and projections, managers need a better understanding of the mechanisms driving slower growth. Our working hypothesis is that the decrease in size-at-age is diet-driven, potentially resulting from changes in prey availability. During the summers of 2012 and 2013 we sampled sex, length, location, date of catch, stomach contents, flesh tissue and the otolith from 703 halibut landed by the Homer sport-charter fishery. We used a size-based design aimed at collecting at least 30 males and females from as many 10-cm size groups between 40 and 200 cm as possible. Otoliths were aged following IPHC break and bake protocols and dietary proportions were established for each fish using stomach contents and stable isotopes ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) of prey items, flesh samples and otolith. We sampled 222 male halibut ranging from 41 - 107 cm long and 4 - 27 years old, and 481 females from 24 - 200 cm long, 2 - 25 years old. . Nearly a quarter of stomachs were empty (266 samples assessed) while 40% contained fish (sand lance, herring, flatfish, pollock, Pacific cod and hooligan), 37% had crabs (rock, hermit, tanner and decorator), 9% had cephalopods, and 9% contained fishing bait (e.g. herring, octopus). Stable isotope analysis (complete for 197 samples) indicate a wide breadth of prey assimilation with  $\delta^{13}\text{C} = -14.75$  to  $-18.73$ ,  $\delta^{15}\text{N} = 13.87$  to  $19.02$ . Results from the IPHC in the late 1990s showed slightly lower  $\delta^{13}\text{C}$  ranges and a similar range for  $\delta^{15}\text{N}$ .

*Gulf of Alaska - Fish and Fish Habitat***Seasonal Habitat Use And Productivity Of Commercially Important Rockfish In The Gulf Of Alaska**

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The 1996 reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act mandates the identification of Essential Fish Habitat (EFH) for each life stage of federally managed fish species. Essential Fish Habitat includes the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. Our understanding of EFH for many rockfish species in the Gulf of Alaska (GOA) is rudimentary, especially their seasonal habitat requirements and the relative importance of specific habitat types. It is generally accepted that rockfish in the GOA have patchy distributions that frequently occur in rocky, hard, or high relief substrate. Many commercially important rockfish species are also associated with coral and sponge habitats in Alaska waters. The added complexity provided by coral and sponge habitats may offer juvenile and adult rockfish increased protection from predators and/or enhanced food resources similar to other structurally complex habitats. More data are needed to understand the seasonal habitat use patterns of rockfish within the GOA as well as the importance of high relief habitats that contain biotic structures, particularly coral and sponge. We are conducting a project examining the seasonality of rockfish distribution, abundance, and productivity across three habitat types: low relief, high relief rocky/boulder, and high relief coral/sponge. Research cruises are being conducted during the summer, winter, and spring (2013-2014) at two study sites in the central GOA, focusing on three commercially important rockfish species (Pacific ocean perch, *Sebastes alutus*, northern rockfish, *S. polyspinis*, and dusky rockfish, *S. variabilis*). In each sampling period, we are using an underwater stereo drop camera system to examine rockfish habitat associations, community structure, size structure and density within each habitat type and a bottom trawl and bongo net to collect fish and zooplankton. Specimens will be collected to examine differences in prey availability, diet diversity, and reproductive potential among the habitats. Habitat quality will be indirectly assessed by examining rockfish energy content, body condition, and growth potential. This research will enable us to better understand the relative importance of particular habitats to rockfish productivity throughout the year and provide data critical for understanding EFH for these species.

*Gulf of Alaska - Fish and Fish Habitat*

**An Individual Based Model Of Sablefish: Exploring The Connectivity Between Spawning And Nursery Grounds In The Gulf Of Alaska.**

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Sablefish, perhaps better known as Black Cod, have been targeted by U.S. fishermen since the late 1800s because of their high value and unique flavor. Historically, there has been about a four-fold variation in year class strength in this fisheries resource, but the causes for this variability are not known. Sablefish spawn pelagic eggs in winter in deep water near the edge of the continental shelf. Prior to hatch, the eggs sink to depths exceeding 400-500 m. The eggs and larvae develop at depth but as the yolk sac is absorbed, larvae swim to the surface and are part of the neuston community throughout the spring. Young sablefish move inshore at the surface towards relatively shallow inshore sites. If the young sablefish thrive and manage to reach a suitable 'settlement' site they will recruit to the adult population. As part of the Modeling Component of the North Pacific Research Board's Gulf of Alaska Integrated Ecosystem Research Program (GOA-IERP) we have developed an Individual-Based Models of sablefish coupled to a ROMS hydrographic model of the Gulf of Alaska. The model will be a valuable tool to examine recruitment mechanisms and estimate the connectivity between spawning and juvenile nursery areas. Here we present preliminary results of the inter-annual variability in connectivity between sablefish spawning and recruitment sites in the Gulf of Alaska and discuss the driving factors behind this variability.

*Gulf of Alaska - Fish and Fish Habitat*

**Bomb Dating And Age Estimates Of Big (*Beringraja Binocularata*) And Longnose (*Raja Rhina*) Skates**

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Age and growth curve estimates have been produced for (*Beringraja binocularata* [formerly *Raja binocularata*]) and longnose skate (*Raja rhina*) populations in the Gulf of Alaska, British Columbia and California. Age estimation for these two skate species relies on growth band counts of sectioned vertebrae. However these studies have not produced similar results for either species, highlighting the need for age validation. Archived large specimens of big skate and longnose skate collected in 1980 and 1981 had minimum age estimates old enough to suggest that radiocarbon ( $^{14}\text{C}$ ) signals from bomb testing conducted in the late-1960s can be used to establish dates of growth band formation. We present results of the  $\Delta^{14}\text{C}$  in these samples and compare them to reference  $\Delta^{14}\text{C}$  marine teleost otolith chronologies that exist for North Pacific. We suggest criteria for growth band counts and inter-agency standardization in age estimates throughout the range of both species.



*Gulf of Alaska - Fish and Fish Habitat***A Bayesian Assessment Of Prince William Sound Herring**

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Shortly after the Exxon Valdez Oil Spill, the Pacific herring (*Clupea pallasii*) population in the Prince William Sound (PWS) crashed and has not yet recovered. Commercial fishing of herring in the PWS management area was closed in 1993 and remains closed due to low spawning biomass. To improve current research on the driving factors behind the lack of full recovery, we improved the assessment model and plan to determine which data types are most valuable for hypothesis testing and modeling efforts. We converted the age-structured assessment model used by the Alaska Department of Fish and Game (ADFG) to manage the PWS herring population into a maximum likelihood and Bayesian framework. We used this model to improve model output by estimating confidence intervals around model parameters and key management quantities such as ending year biomass. The Bayesian version of the model additionally allows for the incorporation of additional biological information through informative priors. In addition, improvements to the ADFG model output include assignments of probabilities to alternative hypotheses concerning dynamics or alternative states of the herring population, and intuitive representations of uncertainty in the form of credible intervals. We plan to use the revised model in a simulation study to determine which data types are most informative when answering important management questions, thus providing critical information to prioritize current and future monitoring efforts.

*Gulf of Alaska - Fish and Fish Habitat***Connectivity Of Pacific Cod Spawning And Nursery Areas In The Gulf Of Alaska**

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Pacific cod (*Gadus macrocephalus*) is the subject of a large fishery in the Gulf of Alaska (GOA) and is one of the five focal species of NPRB's GOAIERP (Gulf of Alaska Integrated Ecosystems Research Program). A better understanding of recruitment processes, which is GOAIERP's goal, would help with management of this species. To this end, we have developed an individual-based model in order to examine transport and biological processes affecting the early life stages of Pacific cod. An important process that we are examining is "connectivity", ie. the connections between adult spawning locations and juvenile nursery areas. We hypothesize that successful connectivity is critical to recruitment success, and that its variability relates to variability in recruitment. Pacific cod spawn in waters less than 200 m deep. The life stages included in the model are eggs, yolk-sac larvae, preflexion and postflexion larvae, epipelagic juveniles, and settled juveniles. Eggs in the model are released in March, April, May and June. Depth distributions of eggs, larvae and juveniles are included in the model. Settlers are found in areas where the water is less than 70 m deep. Growth processes and stage durations in the model are related to temperature. In this presentation, we present a preliminary analysis of the connectivity of Pacific cod, for three years. We test the difference between connectivity for these years, and examine how differences found relate to recruitment. We also examine the percent of survivors among those spawned, and the percent of settlers of those that reach the juvenile stage. This analysis will be a precursor to a larger connectivity analysis for all of the years between 1995 and 2012, in an attempt to correlate variability in connectivity to variability in recruitment.

*Gulf of Alaska - Fish and Fish Habitat***Correlation Between Otolith And Muscle  $\delta^{13}\text{C}$  Values Supports The Use Of Otoliths As Diet Proxies In Wild-Caught Black Rockfish (*Sebastes Melanops*)**

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Otolith carbon isotope ( $\delta^{13}\text{C}$ ) values may provide temporally resolved diet proxies in fish. If otolith  $\delta^{13}\text{C}$  values reflect diet, isotope values from recent otolith tissue and muscle tissue should correlate and known ontogenetic diet shifts should be reflected in comparisons between otolith materials from different ages. We analyzed paired otolith and muscle samples for  $\delta^{13}\text{C}$  from black rockfish (*Sebastes melanops*) to examine the potential of otoliths to reflect diet. We found a strong correlation between  $\delta^{13}\text{C}$  values from recent (~12 months) otolith material and muscle tissue in fish >300mm in length ( $r^2 = 0.54$ ,  $P < 0.0001$ ), but a marginally significant relationship in smaller fish 200-299mm in length ( $r^2 = 0.13$ ,  $P = 0.07$ ). Isotopic turnover in muscle tissue of smaller fish may be faster than one year, violating the assumption that otolith and muscle represent the same time period and leading to a poor correlation. Within individual otoliths,  $\delta^{13}\text{C}$  values were enriched by ~3‰ in recent otolith edge material compared to age-0 otolith core material and were consistent with known nearshore-offshore gradients in  $\delta^{13}\text{C}$  values at the base of the foodweb, rather than nearshore-offshore gradients in DIC  $\delta^{13}\text{C}$ . In combination with similar observations in experimental settings, these results support the use of otoliths as diet proxies. If applied to historic or ancient otolith archives,  $\delta^{13}\text{C}$  analysis provides a way to examine trophic and ecosystem level shifts that have occurred concurrently with changes in habitat, commercial fishing, invasive species, climate change, and other direct or indirect human impacts.

*Gulf of Alaska - Fish and Fish Habitat*

**Scales As Growth History Records For Pacific Herring *Clupea Pallasii* In Prince William Sound.**

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Robust Pacific herring (*Clupea pallasii*) populations, suitable for exploitation by commercial fisheries, are typically sustained by periodic recruitment of strong year classes into the adult spawning population. However, the Prince William Sound (PWS) herring population has not had a strong recruitment class since 1989, when the Exxon Valdez Oil Spill occurred. Identification of conditions limiting herring recovery will require a series of focused process studies combined with monitoring of the natural conditions that affect herring survival. Fish grow in response to the extrinsic influences of their environment constrained by the intrinsic influences of genetic predisposition for growth and of size already attained. Understanding how these intrinsic and extrinsic sources of variability influence growth is important for several reasons. Variation in growth has a strong effect on the selection of appropriate harvest policies based on demographic models that reflect the natural processes. Analysis of growth increments between annular patterns on scales can provide a means to reconstruct past growth changes that can assist in determining the possible environmental and density-dependent causes of growth variation. Growth increment information incorporates a longitudinal history of growth that increases the effective degrees of freedom and can be used in modeling changes in growth in relationship to environmental and population indices.

*Gulf of Alaska - Fish and Fish Habitat*

**Fatty Acid Biomarkers Reveal Dietary Variation And Trophic Relationships Among Nearshore Fish Assemblages In The Gulf Of Alaska**

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The Gulf of Alaska (GOA) ecosystem is complex and displays substantial spatial and temporal variability in regards to nearshore fish communities. Further, trophic relationships within the nearshore community are often complex and difficult to study by traditional methods, such as stomach content analysis. A more synoptic view of trophic interactions among fish assemblages can be achieved using fatty acid (FA) analysis. In 2011, several nearshore surveys of fish assemblages were conducted in the GOA to investigate competition among co-habiting species. FA signatures were used to infer diets and elucidate relationships between several fish species in similar life stages (e.g. YOY, juvenile) at a number of spatial and temporal scales. Preliminary data suggested substantial variation in FA profiles of Pacific cod (*Gadus macrocephalus*) and saffron cod (*Eleginus gracilis*) by habitat. In contrast, temporal variation in greenling (*Hexagrammos spp.*) FA collected in the summer and fall was greater than that associated with habitat. Within the same habitat and season, several species, such as shiner perch (*Cymatogaster aggregate*), pricklebacks (family *Stichaeidae*), greenlings, Pacific cod and rockfish (family *Sebastidae*), showed very little overlap in FA signatures. Comparable samples from surveys conducted in 2013 will be assessed to determine annual variation in the relationships between these fish species and other forage community members.

*Gulf of Alaska - Fish and Fish Habitat*

**Pilot-Scale Development Of Laser Ablation – Isotope Ratio Mass Spectrometry (LA-IRMS) For Use In Retrospective Studies Of Marine Productivity In The North Pacific Ocean**

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Stable isotope analysis (SIA) is an important tool for characterizing energy flow and trophic relationships in aquatic ecosystems and typically involves contemporary analysis of whole organisms and tissues, or of archival samples that are collected and maintained because of their scientific or economic significance. Archives of otoliths, scales and bone of commercially important fish species can be of particular value in SIA because they provide an opportunity to retrospectively identify factors that influence long-term changes in stock abundance, but their analysis has been generally restricted to whole or partial sample measurements that represent an integrated lifetime or temporally limited isotope signal. Laser ablation – isotope ratio mass spectrometry (LA-IRMS) is a recently developed technique for SIA that uses spatially resolved isotope analysis to overcome these limitations and provide estimates of annual and even seasonal energy flow from archived samples with resolution that was previously unavailable. We are testing the utility of this technique to determine the relationship between carbon isotope values within herring scales and whole herring from Prince William Sound by comparing samples of these fish obtained during energy rich (fall) and energy depleted (spring) time periods. Establishing this relationship will determine if the extensive (Alaska Dept. of Fish and Game) scale archive for this population can be used in a subsequent retrospective analysis to provide information aimed at understanding the dynamics of fish stocks during a period of major biological and physical change in the North Pacific Ocean (ca. 1970 to present).

*Gulf of Alaska - Fish and Fish Habitat*

**Prince William Sound Herring Research**

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This poster provides an update on the Exxon Valdez Oil Spill Trustee Council (EVOSTC) sponsored herring research program in Prince William Sound. In the past year the PWS Herring Survey program was completed with final reports and synthesis submitted to the EVOSTC. We are now in the second year of the follow-on Herring Research and Monitoring (HRM) program. A brief description of findings from both programs is provided.

*Gulf of Alaska - Humans*

**2013 Alaska Marine Debris Surveys**

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The National Marine Fisheries Service sampled derelict fishing gear and other plastic debris on beaches in Alaska periodically from 1972 to 2008 and more recently in 2012 and 2013. The 2012 and 2013 surveys included additional beach segments to encompass the eastern Gulf of Alaska coast. The 2013 survey sampled 30 beach segments for the presence of anthropogenic marine debris. This study builds on the findings from the 2012 surveys and presents trends in abundance and composition of marine debris on Alaskan shores and compares these trends to what was historically found. The 2013 study also continues to assess the presence of marine debris from the 2011 Japanese tsunami and its relationship to these trends.



*Gulf of Alaska - Humans*

**Dredging Up Strengths, Weaknesses, Opportunities And Threats To The Alaskan Weathervane Scallop Fishery**

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We report the findings of a socioeconomic assessment of the commercial weathervane scallop fishery off Alaska. The research was structured within the framework of a SWOT (strengths, weaknesses, opportunities, threats) analysis, a strategy commonly used to analyze the internal (strengths, weaknesses) and external (opportunities, threats) components of an industry. Within the SWOT framework, we focused on five categories: socio-cultural, technological, economic, environmental, and regulatory. Semi-structured interviews were conducted with 26 participants who had detailed knowledge of the fishery, including industry members, fishery managers, biologists, and members of coastal communities affected by the fishery. Participants were interviewed from communities including Juneau, Kodiak, Yakutat, Homer, Cordova, Anchorage and Seattle. We addressed topics such as attitudes of the Alaskan public towards scallop dredging, impacts of the scallop industry on Alaskan coastal communities, market influences of East Coast and imported scallops, changes in the management of the fishery, and a number of environmental considerations. Questions also addressed the risks and benefits of scallop industry participation in Community Supported Fisheries (CSFs) in Alaska. Several unifying opinions emerged from this study, including a lack of awareness of the fishery in many Alaskan communities and fears about rising fuel costs and diminishing harvest levels. The majority of participants consider the fishery to be managed sustainably, although the lack of data available on scallop recruitment and abundance is a large concern. This analysis provides relevant information to both fishery managers and the scallop industry to contribute to the environmental, economic, and social sustainability of the scallop fishery.

*Gulf of Alaska - Humans*

**Metrics To Monitor The Status Of Fishing Communities: An Alaska State Of The State Retrospective 1980-2010**

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We outline a suite of 11 quantitative metrics which provide information on the economic and demographic status of fishing communities, presenting data from 324 Alaskan communities over 1980-2010. These metrics provide an initial data set for descriptive analyses of fishing community status and for exploratory analyses to identify hypotheses for subsequent in-depth study of the socioecological dynamics of Alaskan fishing communities. Metrics were derived by collating information from publicly available databases and include information on fishing portfolios, fishing revenues, fishermen demographics, and fleet characteristics. As demonstration of the community metrics, we examine metric trends in detail for three communities (Kodiak, Sitka, and Togiak), and provide state-wide temporal and spatial assessments to characterize historical dynamics of Alaska's fishing communities. Statewide assessments show synchrony in the dynamics of some metrics, such as increasing population, declining permit ownership, and improving per-fishermen gross revenues, but show considerable variation amongst communities for other metrics, such as the diversification of communities' fishing portfolios and investments into fleets. Spatial distributions of metrics suggest the western and northern parts of Alaska have experienced greater declines in metrics associated with commercial fisheries importance and performance relative to the southern and eastern regions.

*Gulf of Alaska - Humans*

**Paralytic Shellfish Poisoning: Preparation Of Monoclonal Antibodies To Saxitoxins For Use In PSP Detection**

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Paralytic shellfish poisoning (PSP) is caused by the consumption of shellfish contaminated with saxitoxins (STX). STXs are produced by dinoflagellates in the genus *Alexandrium* and readily accumulate in marine food chains. Attempts to measure STXs are complicated because the composition of STX structural forms found in shellfish samples can vary greatly. Detection of STX is currently done by costly, time consuming techniques. No rapid detection method is currently capable of accurately detecting all of the STX variants responsible for causing PSP. In NPRB Project #1118, we have developed three new enzyme-linked immunoassays (ELISAs) that detect the major forms of saxitoxins, including neosaxitoxin, one of the major toxic STX variants which is under reported in current polyclonal ELISA tests on the market. Our assays employ a microtiter plate format for rapid quantitation of STX and are designed for testing large numbers of samples in a laboratory setting. The sensitivity and specificity of the assays are being calibrated using both spiked and natural shellfish samples containing different toxin profiles. Work is ongoing to develop a combined, rapid and low cost test kit suitable for monitoring shellfish for the risk of paralytic shellfish poisoning. Future validation studies and the development of commercially available products are discussed.

*Gulf of Alaska - Lower Trophic Levels*

**Development Of Biochemical Measures Of Age In The Alaskan Red King Crab:  
Towards Quantifying Thermal Effect On Aging**

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Age determination of marine organisms is a central metric for understanding the timing and magnitude of spawning, recruitment and habitat use, juvenile duration, and population age structure. For the commercially important red king crab (RKC), *Paralithodes camtschaticus*, size-based models are used in lieu of age-based models for estimating population dynamics and for fishery management. Yet we know that crab growth and thus size is not a linear process, but typically is seen as a step function with intermittent molts of varied periodicity which complicates the estimation of population dynamics and timing of key life history parameters using carapace size alone. We are developing an alternative approach based on analysis of specific age pigments (*lipofuscins*) to assess RKC age to provide a more robust metric of age than carapace size measurements alone. After preliminary validation of the presence and utility of these biochemical markers for known age animal ages (0-4 years) in the first project year, we initiated a long term experimental assay to assess effect of temperature on age pigment accumulation rates in juvenile RKC. A total of 285 newly settled RKC juveniles were set at 2C, 12C and ambient (5-7C) thermal regimes in the laboratory. Predictable changes in molting and growth rates in relation to temperature were accompanied with low mortality, which provides good potential for quantifying functional relation between aging and temperature as accumulation of aging products are analyzed.

*Gulf of Alaska - Lower Trophic Levels***Gulf Of Alaska Integrated Ecosystem Program, Lower Trophic Level: Observations On The Larval Fish Communities In The Eastern And Western Gulf Of Alaska From 2011 Field Collections**

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The Gulf of Alaska Integrated Ecosystem Program (GOA-IERP) is a four year (2011–2014) multi-disciplinary study examining interactions between physical and biological oceanography to understand how the environment influences the survival of early life history stages (egg to young-of-the-year) and recruitment of five commercially and ecologically important groundfishes: Walleye Pollock (*Gadus chalcogrammus*), Pacific Cod (*Gadus macrocephalus*), Arrowtooth Flounder (*Atheresthes stomias*), Sablefish (*Anoplopoma fimbria*) and Pacific Ocean Perch (*Sebastes alutus*). Biological and oceanographic surveys in the eastern and western Gulf of Alaska were conducted during two primary field seasons (2011 and 2013). Based on a long-term, 20-year historical series, ichthyoplankton communities are well known in the western region, but the eastern region of the Gulf of Alaska is relatively unknown. We present a summary of larval fish data collected during the 2011 field season from the eastern and western Gulf of Alaska in spring and summer. Preliminary results comparing spring larval fish distributions to modeled circulation indicate that eddies may play a role in transport onto the shelf. Presently, Pacific Ocean Perch are indistinguishable from other species of rockfish larvae. As a result, larval rockfishes are identified only to genus level (*Sebastes spp.*), but ancillary genetic studies are helping resolve this problem. Our results provide new information on larval fish communities in the eastern Gulf of Alaska, a region that has not been well sampled for either oceanography or biology, and highlight both similarities and differences between the eastern and western ichthyoplankton communities. Data from samples obtained during the 2013 spring and summer field season will be available by early 2014. Field observations indicated that all target taxa were collected in spring.

*Gulf of Alaska - Lower Trophic Levels*

**Taxonomic Composition Affects Phytodetritus Nutritional Value, With Consequences For Egg Production In A Deposit-Feeding Sea Cucumber**

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Phytoplankton vary in biochemical composition, including relative amounts and types of fatty acids (FA) they produce. Northeast Pacific waters have recently exhibited shifts in composition of phytoplankton assemblages, with smaller taxa proliferating where diatoms once dominated. Such shifts may cause changes in nutritional value of phytodetritus available to consumers. Many essential FAs cannot be synthesized by animals, and must come from primary producers in the diet. FAs are vital to egg formation, adding membrane structure and yolk energy. We investigated effects of phytoplankton diets on *Parastichopus californicus* reproduction and FA provisioning of eggs. For 32 weeks, we maintained adult animals on the diatom *Thalassiosira* or the chlorophyte *Tetraselmis*, both native species to the Northeast Pacific. Spawning was then induced, and fecundity, egg sizes, and pre-feeding larval developmental and survival rates were recorded. Females fed *Tetraselmis* showed higher fecundity, while larvae from females fed *Thalassiosira* had higher survival rates; egg sizes and larval development rates did not differ between treatments. Subsamples of eggs were analyzed for lipid and FA composition to determine whether dietary FA differences were reflected in the eggs.

*Gulf of Alaska - Lower Trophic Levels*

**Zooplankton Community Structure Around The Gulf Of Alaska**

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Plankton communities underpin the productive shelf ecosystems, including valuable fisheries, which border the Gulf of Alaska. The Continuous Plankton Recorder transects, collecting samples that are used to identify and count planktonic organisms, have crossed from the ocean to the shelf in 4 locations; east of Unimak pass in the Aleutians, south of Cook Inlet, south of Prince William Sound and west of Juan de Fuca Strait. While seasonal and annual coverage has varied at these sites, data for most regions date back to 2000. This presentation compares the community structure of the zooplankton at each location and through time. Some changes occur across the wider region, indicating a large-scale response to climate variability, while others are more locally responsive. Changes in community structure have implications for higher trophic levels through the resulting changes in prey availability and nutritional content.

*Gulf of Alaska - Lower Trophic Levels*

**Dietary Lipid Affects The Nutrition And Condition Of Red King Crab Larvae  
(*Paralithodes Camtschaticus*)**

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Six of nine red king crab stocks in Alaska crashed, the fisheries are closed, and stocks have not recovered. The Alaska King Crab Research Rehabilitation and Biology (AKCRRAB) program is investigating the feasibility of enhancement to rehabilitate these stocks. The goal of this research project is to improve larval survival through improved nutrition and therefore increase hatchery larval production. We raised larvae from eight ovigerous red king crab females in twelve 190 L tanks at the Alutiiq Pride Shellfish Hatchery, in Seward, Alaska and varied the nutritional content of the larval diet by feeding larvae *Artemia nauplii* enriched with lipid emulsions varying essential fatty acids: 1) high DHA, 2) high DHA and EPA, 3) high DHA and AA, and 4) a control lipid. We found similar larval survival to glaucothoe among the diet treatments. Larval condition during the 4 zoeal stages (assessed by viewing size and number of lipid droplets) generally did not vary among diets; however, the glaucothoe fed diets enriched with high DHA and EPA and high DHA and AA had more and larger lipid droplets than the DHA and control lipid diets. During a stress test that measured response time after exposure to freshwater, glaucothoe that were fed the diet enriched with the control lipid recovered significantly slower than the other diets, suggesting that diet can improve performance during stress. Plans this fall are to examine the biochemical composition of the larvae as a measure of larval condition and to evaluate if the hatchery observations are good indices of biochemical condition. Results from this study will be used to improve diets of hatchery-reared king crab to increase larval production.



*Gulf of Alaska - Lower Trophic Levels***Factors Influencing Timing And Intensity Of Production On The Gulf Of Alaska Shelf**

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The Global Ocean Ecosystem Dynamics program was tasked with elucidating mechanisms linking climate to the ecosystem response on the Gulf of Alaska shelf. However, broad spatial-temporal interpretation of field observations from the Gulf of Alaska is complicated by the complex physical environment. Two major currents, the Alaska Coastal Current and Alaskan Stream, generate eddies and meanders which mix oceanic and coastal communities to varying degrees. Field observations at any location and time are the result of these mixing processes as water masses move east to west along the shelf. Since the oceanic environment is a small-cell phytoplankton community, with high-nitrate, low-chlorophyll and iron-limitation, and the inner shelf is characterized by large phytoplankton cells, high production and nitrate limitation during summer, field observations at specific locations can rapidly change as water masses, mixed to varying degrees, move past the stations. A regional ocean circulation model with embedded ecosystem components provided a formal mechanism for expanding interpretation of field observations beyond the time – space constraints imposed by sampling logistics. We ran the model for 1996 through 2011 to examine long-term trends in iron and nitrate concentrations, plankton biomass and production on the northern Gulf of Alaska shelf. Preliminary results indicate that production and biomass are influenced by the balance of iron and nitrate concentration over the shelf. The timing and intensity of spring production was influenced by the volume of freshwater discharge in spring, which affected the timing and intensity of stratification and iron concentration and distribution on the shelf. Warmer conditions promoted higher freshwater discharge and elevated iron concentrations in spring 2001 – 2005 which led to higher simulated primary production, while colder condition from 2006 to present had lower spring freshwater discharge, lower iron concentrations and lower simulated production, because more precipitation was sequestered as snow and ice on the continent. The freshwater discharge cycle may be related to the North Pacific Index and the intensity of the Aleutian Low.

*Gulf of Alaska - Lower Trophic Levels***Will Zombie Crabs Increase As Alaskan Waters Warm?**

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The parasitic barnacle *Briarosaccus callosus* can infect all commercially-harvested Alaskan king crab species. Once infected the crabs are transformed into “zombie crabs”. In other words, the parasite does not kill its crab host, but reduces it to no more than a body that is controlled by the parasite. Infected crabs can no longer reproduce; instead they raise and care for the eggs and larvae of the parasite. Prevalence and distribution of *B. callosus* is poorly understood. Most records indicate a low level prevalence (< 1% of crabs infected) throughout Alaskan king crab populations. However, outbreaks have occurred in some areas of southeast Alaska where over 75% of king crabs were infected. *Briarosaccus callosus* outbreaks at this level will greatly reduce reproductive output in king crab populations and likely lead to population declines. Causes of variability in *B. callosus* prevalence have not been identified. There is some evidence that warmer water temperatures may increase survival of *B. callosus* larvae. Due to climate change, increased water temperatures are expected in the Arctic and sub-Arctic, suggesting that *B. callosus* could increase in prevalence. In this study, we are examining the effects of temperature on *B. callosus* larval development and infection rate. To this end, the parasite larvae are raised at a range of temperatures to determine their survival under different temperature regimes. Larvae are then allowed to infect juvenile king crabs to assess how temperature influences infection rate. This study will help determine whether climate change-induced warming will lead to a higher abundance of castrated “zombie crabs” and a decline in fecundity of king crab populations.

*Gulf of Alaska - Lower Trophic Levels*

**Variability Of Iron Supply And Reactivity To The The Gulf Of Alaska Shelf**

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The availability of the essential micronutrient iron (Fe) has been shown to be important for the productivity of the Gulf of Alaska, yet there is scarce Fe data for this region. The NPRB's Gulf of Alaska Ecosystem Research Project investigates interconnections among chemical, physical, and biological parameters of this important region, and as part of this project, the distribution of Fe over the GOA shelf was investigated during the 2011 and 2013 field seasons. Various chemical and physical species of iron were determined to assess its reactivity. Preliminary data from the 2013 season is compared to data obtained during 2011 to begin addressing the interannual and seasonal variability in iron supply and reactivity to the Gulf of Alaska shelf.

*Gulf of Alaska - Lower Trophic Levels*

**Fear Perception And Foraging Habitat Selection Of The Giant Pacific Octopus, *Enteroctopus Dofleini*, In Prince William Sound, AK**

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In Prince William Sound, the Giant Pacific Octopus, (*Enteroctopus dofleini*), occurs at a high density in or near kelp beds. There is very little data to show whether octopuses choose to live in this micro-habitat because it's preferred foraging habitat or an important shelter from predators. The goal of this study was to develop an experimental technique suitable to quantify the effects of predation risk on the behavior of the Giant Pacific Octopus in Prince William Sound, AK relative to habitat. Octopuses may or may not behave like an optimal forager. An optimal forager will choose to forage in a patch that they assume to be less risky. For most animals the safer patch is found to be the patch closer to cover where the animal can hide easily. One way to measure how animals perceive risk is to use giving up densities. The giving up density is the density of food left in a patch after an animal has finished foraging in that patch. In previous studies, this technique has been used with small rodents who seem to use cover as a way to reduce predation risk. Understanding how predation risk affects the Giant Pacific Octopus may help us create a better understanding of their ecology. Artificial food patches were made from 16.5 gallon plastic tubs with PVC pipe used as the substrate with artificial clams, made from empty clam shells glued together with 5g of shrimp inside, mixed throughout. These patches were placed in the intertidal zone and left for about 24 hours. The remaining artificial clams left in the food patches varied with the perceived predation risk. Results showed that octopuses will forage in artificial food patches and tend to choose to forage more in cover than out in the open. Starfish were also found to forage in the food patches also creating a giving up density.

*Gulf of Alaska - Lower Trophic Levels*

**Image Analysis Of Zooplankton Abundance And Biomass From The Gulf Of Alaska**

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Zooplankton samples collected as part of the North Pacific Research Board's Gulf of Alaska Project are being analyzed for species diversity, abundance, and biomass using the Zooscan digitizing system. Zooplankton community structure is related to physical, chemical, and biological components of the Gulf ecosystem, with implications for fish survival and recruitment. In this study, zooplankton prey availability and growth is discussed from 2010, 2011, and 2013 samples. Preliminary comparison is also made with modeling results from other components of the Gulf of Alaska Project.

*Gulf of Alaska - Lower Trophic Levels*

**Digitized Zooplankton Community Structure Estimates In The Gulf Of Alaska**

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The Gulf of Alaska Project seeks to find the relationships between physics, plankton and fish. The project has amassed more than 1000 zooplankton samples for this purpose over 3 years from 2011-2013. To expedite sample processing, we have employed a neural-net image-analysis system, "Zooscan," to estimate abundance and biomass of major zooplankton functional groups. We will present the basic pattern observed, comparing the broad shelf of the northwestern Gulf to the narrow southeastern shelf. Seasonal and interannual differences will be illustrated. Zooplankton will be related to the concurrent physical, chemical, and biological components of the Gulf ecosystem, with preliminary comparison made to modeling results from other components of the Gulf of Alaska Project.

*Gulf of Alaska - Mammals*

**Blubber Store Estimates Of Beluga Whales (*Delphinapterus Leucas*) From Bristol Bay, Alaska.**

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Blubber performs several major functions in marine mammals, including insulation, reduced costs of locomotion through streamlining, and stored energy reserves for periods of reduced foraging, and is an indicator of an animal's overall health and body condition. As part of a comprehensive health assessment study of beluga whales from Bristol Bay, Alaska, we measured blubber depth using high resolution ultrasound and caloric content of blubber from full core biopsies. In order to estimate the total body energy stores available to belugas from blubber, we calculated blubber stores using two methods: 1) simple proportion of estimated body mass (Sergeant and Brodie 1969); and 2) ultrasound depth measurements (Gales and Burton 1987). We used simple linear regression to estimate body mass (kg) from axillary girth (cm) based on data from captive belugas. The average mass of Bristol Bay beluga whales is 687.3 kg +/- 91.1 kg SE, which results in average blubber mass of 274.9 kg +/- 36.5 kg based on estimated proportion of body mass of 40%(method 1). These estimates will be compared to calculations from method 2. These data will be used to develop an individual-based population-level energetics model of Cook Inlet beluga whales in order to determine if reduced energy availability may be contributing to their failure to recover.

*Gulf of Alaska - Mammals***Case Study: Multi-Faceted Response to an Entangled Humpback Whale in Southeast Alaska, August 23-September 5, 2013**

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On August 23, 2013, an adult humpback whale became entangled in a commercially fished gillnet in Frederick Sound near Petersburg. A NOAA Fisheries trained and authorized entanglement response team arrived on scene and worked to disentangle the whale while the fishing vessel was connected to the gear. Deteriorating weather and safety issues necessitated cutting the whale free of the vessel and attaching a GPS-based satellite tag package for continued monitoring of the animal. Over the next 14 days while the whale covered 435 nautical miles, NOAA Fisheries launched a highly coordinated effort to assess, document and respond to the entanglement involving trained teams and specialized gear from four communities in Southeast Alaska. To date, this response is the most long-term, complex and involved in the history of the Alaska Entanglement Response Network. The effort resulted in an unprecedented level of communication, coordination, gear readiness and exchange, attention to safety, and ultimately, a partial removal of gear from the animal. The response provided valuable hands-on experience and problem-solving opportunities for responders while underscoring the importance of assessment and documentation, collaborative decision-making among experts, timely communication with media and the boating public, and the use of satellite technology to address large whale entanglements. During the entire response, the animal remained evasive while carrying trailing gear and tightly wrapped lead line behind its blowhole. Due to the whale's behavior, continued challenges in making contact with gear, remoteness of location, and declining seasonal weather, the effort was terminated and tag retrieved after eight responses. It is hoped that the whale will shed the remainder of gear on its own. Currently, NOAA Fisheries Alaska Region maintains an ongoing partnership with the Hawaiian Humpback Whale National Marine Sanctuary to train personnel and respond to events in Alaska. Since 1998, the network has received over 130 large whale entanglement reports and mounted more than 80 on-water responses (some reports could not be responded to due to time-of-day, weather, and/or remoteness). These responses totally or partially freed more than 40 large whales from life threatening entanglements.



*Gulf of Alaska - Mammals***Coxiella Burnetii Exposure In Multiple Marine Mammal Species Inhabiting The North Pacific Ocean**

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Q-fever is a zoonotic disease with a global distribution, caused by the gram-negative, intracellular bacteria *Coxiella burnetii*. Small ruminants are the most common species to be affected by this bacterium, with disease typically presenting as abortion; however a wide range of species have serological evidence of exposure devoid of associated disease. The organism was first reported in marine mammals in 1998 when it was discovered in the placenta of a Pacific harbor seal (*Phoca vitulina*) off the coast of California. In 2010 *C. burnetii* was identified in 75% of Northern fur seal (*Callorhinus ursinus*) placentas on St. Paul Island, Alaska, igniting interest in exposure and disease potential. To better understand the prevalence and distribution of marine mammals that have been exposed, and which have mounted an adaptive immune response to the organism, archived serum samples were tested for antibodies against *C. burnetii* via an indirect fluorescent antibody assay. From Alaska, we tested serum from Steller sea lions (*Eumetopias jubatus*), Harbor seals, polar bears (*Ursus maritimus*) and Northern sea otters (*Enhydra lutris kenyoni*). For comparison to other geographic areas, we also assayed Steller sea lions, Elephant seals (*Mirounga angustirostris*), California sea lions (*Zalophus californianus*), and Northern fur seals from the Pacific Northwest and California. All species tested had a titer, with the exception of Northern sea otters. Of the animals with a titer, results yielded a range in seroprevalence from 2% to 67%, which varied by both species and geographic location. In general, animals sampled in Alaska had a higher seroprevalence. From these data we are better able to understand the wide range of marine mammals capable of producing antibodies to *C. burnetii* and gain insight as to the spatial parameters of the bacterium.

*Gulf of Alaska - Mammals***Are Recent Changes In Dietary Patterns Of Southern Alaska Resident Killer Whales Leading To Nutritional Stress?**

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Fishes, primarily salmonids, appear to be the predominant prey of resident type killer whales throughout their North Pacific range. As part of a long term study, we detail diet composition for the Southern Alaska resident killer whale population using both direct sampling of prey (fish scales from kill sites) and chemical analyses of skin/blubber biopsies. From 1991-2012 a total of 167 scale samples were collected from kill sites between April 1 and October 1. Of the total salmon scales collected, 5 were from a sockeye (*Onchorhynchus nerka*), 88 were from Coho (*Onchorhynchus kisutch*), 22 were from chum (*Onchorhynchus keta*) and 68 were from Chinook (*Onchorhynchus tshawytscha*). Scales from pinks (*Oncorhynchus gorbuscha*) were conspicuously absent. A total of 134 blubber biopsy samples and analyzed from 2003 to 2012; analyses included stable isotope ratios, fatty acid compositions, and environmental contaminants (POPs). If we assume that the prey (at least in spring, summer and fall) is primarily salmonids, as is indicated by our sampling of scales from predation sites, then the inter-annual trends observed in  $\delta^{15}\text{N}$  stable isotope values are consistent with higher levels of predation on Chinook in early years becoming weighted toward more coho and/or chum in recent years. The blubber compositions of dietary fatty acids and environmental contaminants in this population have also shifted over the last decade and are consistent with a reduction of Chinook and increase in coho and/or chum in the diet. Based on research of killer whale populations in other regions, we propose employing the fatty acid ratio [C16:4n1/C18:4n3] as a potential indicator of nutritional stress for this species. This ratio suggests that: (1) there was an overall slight improvement in nutritional status in more recent years with 2010 being a particular good feeding year (this year also had above average calf recruitment that extended into 2011), (2) the nutritional status of these whales appears to be poorest in the early spring months but gradually improves through fall. Finally, despite decreases in abundance of Chinook salmon in recent years, the substitution of alternative lipid-rich salmonids (eg, coho) appears to be sufficient to maintain good nutritional status.

*Gulf of Alaska - Mammals***Don't Feed The Whales: Humpback Whale Predation At Alaska's Salmon Hatcheries**

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Recently in Southeast Alaska, humpback whales (*Megaptera novaeangliae*) have been increasingly observed feeding on juvenile salmon released from holding pens at hatcheries. To better understand this behavior that threatens their mission of fisheries enhancement, three hatchery organizations agreed to have staff observe five release areas in Southeast Alaska. For 15 minutes twice per day, they noted presence and behavior of humpback whales during the spring releases of juvenile salmon (mid April- late June) in 2010 and 2011. In 2010, humpback whales were observed during releases at all sites. However, whale presence differed significantly among hatcheries ( $F = 5.7$ ,  $df = 4$ ,  $p < 0.001$ ) and was most frequent at Hidden Falls release site. In 2011 humpbacks were observed at two hatcheries. In both years at Hidden Falls a humpback whale was first reported feeding on releases in mid-May, when releases were at their peak. Single whales (and in one case a pair) were subsequently sighted on ten days during a two-week period. Whales used barriers to feed in 87% of whale sightings ( $n=54$ ) with bubbles being the most commonly observed barrier (48%). Using photographic identification, we documented the same individual at Hidden Falls during releases in 2008, 2010, and 2013, demonstrating site fidelity. Future studies will use tag telemetry and concurrent prey sampling to determine humpback whale foraging efficiency in this unique situation where the initial size, species, abundance and quality of prey items are known. We will quantify how the foraging opportunity provided by hatchery releases compares to wild prey options using methodologically similar data we collected for whales feeding on krill (*Euphausia pacifica*,  $n=6$ ) and herring (*Clupea pallasii*,  $n=6$ ) in Southeast Alaska. These ecological studies, coupled with economic analyses, aim to identify practical release strategies that minimize humpback whale predation at hatcheries and preserve the economic benefit of hatcheries.

*Gulf of Alaska - Mammals***Fetal Growth Of Harbor Seals (*Phoca Vitulina*) In Alaska**

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Harbor seals in Alaska have experienced significant population fluctuations in recent decades. Although population trends in many locations are now stable or increasing, some, such as in Glacier Bay, are still declining and other areas such as the western Gulf of Alaska remain depressed and vulnerable to environmental and anthropogenic pressures. What has caused and is still causing these declines is unclear. Understanding what is occurring reproductively with these populations is a crucial step in understanding the current and future state of the populations, and is essential to have baseline data to measure future changes. Fetal growth is a portion of my overall research examining harbor seal reproductive characteristics in Alaska. The samples used for this research come from the Alaska Native Harbor Seal Commission's (ANHSC) Biosampling Program conducted from 1996 to 2005. Using a sample size of 27 fetuses from Prince William Sound, Kodiak, and southeast Alaska, we contrasted various morphometric measurements across the gestation period. The gestation period ranged from 0 to 45 weeks, with 0 corresponding to an assigned September implantation date and 35 to 45 weeks corresponding to a May to mid-July birthing period. Of the 27 fetuses, 9 were between 0 and 15 weeks, 16 between 16 and 30 weeks, and 2 between 31 and 45 weeks of gestation. The measurements examined included standard and curvilinear length, axillary girth, weight, skull length, condylobasal length (CBL), skull width, and zygomatic width. All of the measurements showed a strong linear relationship with the age of the fetus, excluding weight which increased exponentially over the gestation period. There was no significant difference between male and female fetuses for any of the measures. Using subsistence-hunted samples provides a unique opportunity to be able to study fetal growth that would otherwise be nearly impossible under current restrictions to marine mammal research.

*Gulf of Alaska - Mammals***Use Of Ephemeral Features By Harbor Seals In The Eastern Gulf Of Alaska**

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Marine predators are often used as indicators of biological productivity in remote ocean regions as they are efficient samplers of the marine environment and likely indicators of prey availability. In the Northeast Pacific Ocean, the continental shelf and slope region of the eastern Gulf of Alaska is bathymetrically complex and ranges between 30-80 kilometers wide. The region is highly productive; however, it is predominantly a downwelling system and the linkages between primary, secondary, and upper-trophic levels are poorly understood. Harbor seals (*Phoca vitulina richardii*) are one of a suite of marine predators that occur in the eastern Gulf of Alaska yet use of marine habitats in this region by harbor seals is largely unknown. We provide a spatially-explicit description of the use of the continental shelf region of the eastern Gulf of Alaska by female harbor seals as a foraging area and a migratory corridor. A behaviorally discriminating state-space model was used to infer the behavioral state (resident, traveling) of individual harbor seals from satellite telemetry locations and revealed focused use of both inner shelf and outer shelf waters by harbor seals. The majority (79%) of harbor seal locations occurred in the inner shelf region (< 20km from shore) and use was highest between January and May. During late-winter and spring, focal regions of harbor seals occurred near spring-spawning aggregations of eulachon and herring. Approximately 21% of seal locations occurred along the outer shelf region (>20 km of shore) and use was highest between September and December. Focal regions used by seals along the outer shelf region occurred along the periphery of mesoscale anticyclonic eddies. The use of the inner and outer shelf of the eastern Gulf of Alaska by harbor seals varied seasonally and suggests that there may be multiple ephemeral features including aggregations of seasonally available fish and anti-cyclonic eddies that likely create productive foraging conditions for harbor seals and other marine predators along continental shelf region of the eastern Gulf of Alaska.

*Gulf of Alaska - Mammals***Retrospective Analysis Of Cook Inlet Beluga Strandings 1987-2012: Significant Spatial And Temporal Trends.**

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The factors limiting the recovery of the endangered Cook Inlet beluga (*Delphinapterus leucas*) (CIB) whale are not well understood, although stranding events have been identified as a significant threat. Descriptive statistics and a retrospective analysis were conducted of basic Level A data (date, location, gender, age class) gathered from stranding events during 1987-2012. The minimum number of whales that have live and dead stranded since 1987 are 834, and 207, respectively. The proportion of live to dead stranded CIB whales are roughly 80% live stranded to 20% dead stranded. Live and dead strandings have increased since 1987 ( $p < 0.05$ ) and have increased within each age class (adult, sub-adult, calves) with calves having the strongest positive correlation with time. For live strandings, 1994, 1996, and 2003 are potentially abnormal years for overall number of whales or frequency of events. An ANOVA ( $p < 0.05$ ) resulted in a finding of no significant difference between the mean numbers of live stranded whales over the years 1987-2012. Both live and dead strandings have significant spatial/temporal trends per month, sub-region and (some) age classes.

*Gulf of Alaska - Mammals***Tracking Synchronous Growth Of Vibrissae Using Stable Isotopes.**

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Harbor seal (*Phoca vitulina*) vibrissae (whiskers) may be used as a temporal record of diet by analyzing serial sections of vibrissae for stable isotopes. The Alaska Department of Fish and Game, has a large archive of vibrissae from wild caught harbor seals. The sampling protocol was to collect the longest vibrissae, which is found in the caudal and ventral (lower and rear) quadrant of the cheek. However, specific vibrissae were not targeted, so the longest vibrissae may be one of several that grow in this area. In order to interpret stable isotope results from these archived vibrissae, we wanted to examine synchronicity in stable isotope signatures between the 3 longest vibrissae collected from 10 harbor seals. In order for the stable isotopes incorporated into the vibrissae to be similar, the schedule of molt and the growth rates also needs to be similar. We believe that harbor seals shed their vibrissae annually, slightly before hair molt. Past studies estimate a period of fast growth (~0.78 mm/day) and slower growth (~0.075 mm/d) by identifying uptake of <sup>13</sup>C- and <sup>15</sup>N-labeled glycine in vibrissae collected during different parts of the year. Data will be presented comparing isotopic signatures from serial sections of the three “longest” vibrissae per individual (10 seals, 30 total vibrissae) obtained from the University of Alaska Museum of the North; to test for homogeneity between serial sections of the 3 longest vibrissae from individual seals. Homogeneity of the 3 longest vibrissae would suggest that this subset of vibrissae molt at similar times and grow at similar rates throughout the year, and can be used interchangeably during comparative studies.

*Gulf of Alaska - Mammals***Marine Mammal Monitoring In Central And Upper Cook Inlet From Vessel, Land And Aerial Platforms During Spring, Summer And Fall Of 2012 And 2013**

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Few extensive systematic marine mammal (MM) surveys have occurred in central and upper Cook Inlet (CI) that span spring-fall, particularly for the endangered CI beluga whale. From 6 May - 30 Sep 2012, 882 MM sightings (~5,232 individuals) were observed during 6,912 hours (hr) of monitoring in this region for Apache Alaska Corporation's Cook Inlet 3D Seismic Program in near- and offshore waters. Seismic activity took place during a total of 1,842 hr (27% of the total monitoring effort). Six species were confirmed: beluga and gray whales, harbor seal, harbor porpoise, and Steller and California sea lions. Protected Species Observers monitored from three vessels (3,367 hr), land (916 hr), and a helicopter or small plane (92 hr). Aerial surveys occurred daily ~1/2 mile offshore from the McArthur River north to the Susitna River. Passive acoustic monitoring (PAM; 2,537 hr) occurred from one vessel during nighttime and most daytime operations. In 2012, harbor seals were most frequently observed (563 sightings of ~3,471) followed by beluga whales (151 sightings of ~1,463), harbor porpoise (137 sightings of ~190), gray whales (9 single sightings), Steller sea lions (3 sightings of ~4) and California sea lions (1 sighting of ~2). In addition, in 2013, baseline (non-seismic) fixed-wing aerial surveys occurred once per week from 9 May - 31 October (25 surveys totaling approximately 50 hr). Surveys transited from Anchorage ~1/2 mile offshore south along western upper CI to the West Forelands, crossed to East Forelands then north to Chickaloon Bay and Anchorage. No other observation platforms were used and no seismic activity occurred during these flights. Final total observation effort hr, kilometers flown and sighting summaries will be provided at survey completion. The combined 2012 and 2013 monitoring efforts provide extensive systematic data of MM distribution and habitat use of central and upper CI needed to better understand MM/CI beluga whale ecology. In particular, data from central CI has been previously lacking and is important for understanding changes in seasonal distribution patterns along the inlet. Habitat-use analyses of the 2012 and 2013 are ongoing.



*Gulf of Alaska - Mammals***Variability In  $\Delta^{13}\text{C}$  And  $\Delta^{15}\text{N}$  Stable Isotope Signatures Of Steller Sea Lion Pup Vibrissae: Implications For Diet And Foraging Studies**

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From the 1970s to the 1990s, Steller sea lion (*Eumetopias jubatus*) populations declined severely, resulting in the western stock's listing as endangered under the United States Endangered Species Act. In order to form effective management decisions, it is critical to understand the diet of Steller sea lions and which prey species are regionally important to sea lions. One approach has been through stable isotope analysis of their various tissues. Analysis of their vibrissae, or whiskers, provides a sequential representation of that individual's diet from growth in utero to the present. Previous studies have relied heavily on stable isotope signatures along the length of the longest vibrissa from an individual, but variability in stable isotope signatures between vibrissae in a single animal has not been fully explored. In this study, we are testing the assumption that there is no significant difference among vibrissae within an individual by examining the  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  stable isotope signatures of all vibrissae in five Steller sea lion pup carcasses recovered in Alaska. We examined three hypotheses: 1) do stable isotope signatures vary with position on the cheek, 2) do stable isotope signatures vary between the left and right cheeks, and 3) do stable isotope signatures vary among individual pups? We expect no significant difference within or between cheeks, but likely significant differences between pups. If there is significant variability among vibrissae, we would advise correction factors be calculated for application to existing and new data. These results will also inform isotope studies on foraging across taxa using keratin-based tissues. Preliminary results show the mean  $\delta^{13}\text{C}$  is  $-17.90 \pm 0.02\text{‰}$  and the mean  $\delta^{15}\text{N}$  is  $16.18 \pm 0.02\text{‰}$ , which suggests no differences within or between vibrissae of the same Steller sea lion pup.

*Gulf of Alaska - Mammals***Free-Ranging Harbor Seal Pups Experience Maternal Buffering Of Stress Response**

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The effects of mother-infant separation on physiology and behavior of free-ranging Pacific harbor seal (*Phoca vitulina richardii*) pups were studied during capture and handling research procedures. We hypothesized that pups held with their mothers would benefit from social buffering and have measurably lower cortisol concentrations than pups caught without their mothers and held for sampling. We also expected that pups captured with their mother but separated during blood sampling would display increased vocal behaviors and activity levels that were a form of stress response, compared to pups held alone. The presence of the mother significantly buffered the stress response, as measured by reduced cortisol concentrations in pups captured with their mothers as compared to pups captured without their mothers. Weaned pups showed an intermediate hormonal response, likely reflecting ontogeny of a developing physiological stress response. Pups vocalized at a significantly higher rate soon after separation from their mother compared to pups separated from their mothers for a longer period of time. Pups that were recently separated from their mothers, especially male pups, exhibited a high level of activity compared to the pups separated from their mothers for a longer period of time. For the maternal response, mothers with pups had no significant differences in cortisol concentrations from non-lactating females. Mothers with pups tended to have higher initial cortisol concentrations than non-lactating females, although the small sample size of females in this group limited our ability to accurately interpret these findings. The impact of maternal separation on the stress response in harbor seals has highlighted the role of maternal buffering of the stress response. These results provide our first quantitative evidence of the physiology underlying the maternal-pup bond in a marine mammal. The role that maternal buffering plays in the offspring stress response of a social marine mammal demonstrates the benefits of maintaining continuity of mother-offspring dyads during the collection of biological samples.

*Gulf of Alaska - Mammals***Modeling Body Condition In Steller Sea Lions (*Eumetopias Jubatus*): A Comparison Of Isotope Dilution, Ultrasound And Morphometric Approaches**

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Body fat content is a common benchmark for the evaluation of health and overall condition in pinnipeds, as blubber stores reflect not only nutritional status and energy reserves, but also thermoregulatory ability. As field practices have changed, hydrogen-isotope dilution has become the preferred, non-lethal method for determining body composition. This method, however, can be both time consuming and costly for larger animal species and therefore unrealistic for certain field situations. In an effort to provide a potential alternative to deuterium oxide dilution as the sole method for determining body composition (Total Body Water (TBW) and Total Body Fat (TBF)), we sought to develop a predictive model incorporating standard morphometric and ultrasound blubber depth measurements. As part of a greater study, a total of 41 juvenile sea lions from Prince William Sound, Alaska, handled between 2003 and 2008, were included in this comparison. Morphometric data included axial girth, standard length, and mass as well as blubber depths from the dorsal and lateral sides of each animal. In addition to modeling these raw morphometrics as potential predictors of TBW and TBF as determined by isotope dilution, a separate condition index was created for body volume and lean volume, whereby body composition components were estimated as two cones attached at their bases. All models were structured as linear mixed effects models to account for individual variability between animals. In order to evaluate the strength of model predictions, half of the individuals were randomly selected for model generation, leaving the remaining half for cross-validation. Isotope dilution remains the ideal protocol for the non-lethal determination of body composition in pinnipeds, however a simplified model for the prediction of TBW and TBF, utilizing standard morphometrics and ultrasound measures of blubber depth, may provide a reasonable, cost-effective alternative for the assessment of body condition when isotope dilution is not feasible.

*Gulf of Alaska - Mammals***Polycyclic Aromatic Hydrocarbon (PAH) Contamination In Cook Inlet Belugas, Their Prey, And Their Environment Based On Summer Sampling**

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After a sharp decline in the population of Cook Inlet beluga whales during the 1990s, there have been no signs of recovery despite protective measures that severely limited subsistence hunting. The whales were listed as endangered in 2008 and a Conservation Plan was prepared by the National Marine Fisheries Service identifying potential threats that might impede recovery. Our study addresses one concern identified in the Plan: contaminants from oil and gas development and other activities that could introduce polycyclic aromatic hydrocarbons (PAHs) into beluga habitat and prey. The levels and effects of PAHs have received little attention from marine mammal scientists or managers, despite PAHs representing some of the most toxic components of oil. Sixteen PAHs are considered priority pollutants and at least one (benzo-a-pyrene) has been suggested as the cause of high numbers of cancers in belugas from the St. Lawrence Seaway. PAHs have numerous known effects besides carcinogenesis in mammals, including negative effects on reproduction and survival of offspring. Our study assessed PAH levels in sediments and beluga prey from five locations where belugas are observed feeding, and in archived liver and blubber samples from deceased whales. Although naphthalenes, anthracenes, and phenanthrenes were the most ubiquitous/abundant classes of PAHs found in sediments, benzo-a-pyrene was detected in all samples. The data suggest inputs from multiple sources. Most of the PAHs were also detected in fish tissues. King salmon from Ship Creek contained notable levels of total PAHs in their meat; roe from some sockeye salmon was also notably high in total PAHs. The Cook Inlet belugas appear to be bioaccumulating PAHs from the environment and prey. These animals have much higher PAH levels than do subsistence-harvested belugas from MacKenzie River delta. Highest PAH levels in Cook Inlet beluga livers were found in 3 adult males and a female fetus; the highest levels in blubber were from females and fetuses. Our study confirms that concerns about PAH levels and effects on Cook Inlet beluga reproductive success and recovery are justifiable and warrant further study and, potentially, mitigation.

*Gulf of Alaska - Mammals***The Importance Of Basal Food Web  $\Delta^{15}\text{n}$  Values In Trophic Ecology Studies:  
Kodiak Humpback Whale (*Megaptera Novaeangliae*) Case Study**

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Variation in stable carbon ( $^{13}\text{C}/^{12}\text{C}$ ) and nitrogen ( $^{15}\text{N}/^{14}\text{N}$ ) isotope ratios at the base of the food-web propagates to higher trophic levels through diet. Therefore, knowledge of basal food web isotope data from indicator species, such as weathervane scallops (*Patinopecten caurinus*), is needed when investigating trophic patterns within a region using stable isotope analysis. Ten North Pacific humpback whale (*Megaptera novaeangliae*) feeding aggregations have been identified using stable isotope ecology, including an aggregation that encompasses the Kodiak Archipelago. This study explored fine-scale variability in the diets and trophic levels of humpback whales from the Kodiak aggregation between 2004-2012 using stable isotope analysis. Mean  $\delta^{15}\text{N}$  values varied significantly by month ( $F_{5,141} = 6.63$ ,  $p < 0.001$ ,  $R^2 = 0.162$ ) but not year ( $F_{6,139} = 0.901$ ,  $p = 0.496$ ,  $R^2 = -0.004$ ), suggesting annual foraging behaviors follow within-season patterns. Mean  $\delta^{15}\text{N}$  values were most enriched in June and depleted in August with July and September having intermediate values. This pattern was mirrored for trophic level when using total mean basal  $\delta^{15}\text{N}$  from weathervane scallops. However, a different trophic level pattern emerged when monthly mean basal food web  $\delta^{15}\text{N}$  values (June, July, Sept.) were used to estimate trophic level; September became significantly lower in trophic level than June and July. This study highlights the importance of investigating potential seasonal variability in basal  $\delta^{15}\text{N}$  values when conducting fine scale foraging studies using stable isotopes.

*Gulf of Alaska - Mammals***Using Avoidance To Minimize Depredation In The Longline Fishery In Alaskan Waters**

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Both sperm and killer whales depredate sablefish and halibut from demersal longline gear in Alaskan waters. This behavior presents an economic hardship for fishermen and also may cause conservation issues due to the risk of whale entanglement, which is especially of concern due to the “Endangered” listing of sperm whales under the U.S. Endangered Species Act. Information on the timing and movement patterns of sperm whales in the Gulf of Alaska and killer whales in the Bering Sea may provide a means for fishermen to avoid this depredation by whales. Towards that goal, the Southeast Alaska Sperm Whale Avoidance Project (SEASWAP) deployed satellite tags on 21 sperm whales from 2007 to 2014 to document movement patterns and habitat use. Tags were provided through funds from industry and government agencies. Coupling satellite tracking with acoustics and individual sighting histories provided information on movements of sperm whales. In 2007, 2009, 2010 and 2013 locations of sperm whales were available in near-real time to fishermen via the Alaska Longline Fisherman’s Association (ALFA) website. As our sample size increases, utilization distributions are being constructed to identify areas of intense residency by whales in fishery areas, and dive depth-transmitting tags are providing additional detail including the frequency of natural deep dives versus shallow (possible depredation) dives by sperm whales. Dive and location tags would aid in evaluating the efficacy of deterrent testing and help isolate when sperm whales are feeding on offal, or discard. These efforts along with acoustic recordings and visual observations allow hotspots of whale occurrence to be identified. Future use of these methods will determine if some whales are skilled, repeat depredators and if long term association patterns of individuals exist for areas they frequent across years. Continued use of this approach would give fishermen an option to avoid fishing at times or in places when and where whales are predicted to be present, thereby reducing the opportunity for depredation in Alaskan waters. Using avoidance in this manner is a viable option for some fishermen to minimize interactions between fishing operations and sperm whales.

*Gulf of Alaska - Mammals***Beluga Whale Call Source Levels And Detection Range In Cook Inlet**

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Passive acoustic monitoring is a valuable method for studying vocally active animals. Beluga whales (*Delphinapterus leucas*) are known for their high calling rate, making them an ideal species for acoustic studies. The Cook Inlet population of beluga whales are of particular interest since they are listed as endangered and their numbers have been declining at a rate of 1.3 percent annually since 1999. During a two-day deployment in March 2011, a linear array of four bottom-mounted acoustic recorders located at the West Forelands near Trading Bay in Cook Inlet, AK captured numerous beluga vocalizations. Whistle calls were the dominant call type recorded and were captured simultaneously on multiple recorders which had a maximum separation distance of approximately 10 km between the two furthest stations. Localization of calling belugas was performed using two different methods for comparison, time difference of arrival (TDOA) and received signal strength. Source levels were then calculated based on the computed source locations, received levels, and measured transmission loss. Sound levels were measured over the entire 2-day period and the median was used as the background level. This was compared to the average source level to determine an average detection range under these conditions. Such SL measurements can be used for determining the communication space of belugas which is important for understanding how an increase in the background sound level can impact their ability to interact with conspecifics. The detection ranges observed here are greater than previously recorded which could help improve the design of future passive acoustic monitoring studies on Cook Inlet beluga whales.

*Gulf of Alaska - Mammals***Clangs Up High: Sperm Whale (*Physeter Macrocephalus*) Slow Clicks In The Gulf Of Alaska**

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Sperm whales (*Physeter macrocephalus*) are a cosmopolitan species inhabiting all of the major oceans of the world. The Gulf of Alaska represents a little-studied high-latitude feeding ground where male sperm whales interact consistently while depredating commercial longline fishing vessels. This unique interaction may result in different signal usage and behavior compared to sperm whales in other high latitude feeding grounds. Clangs are the least understood of the three types of acoustic signals heard from male sperm whales in high latitudes. This study examined 182 clang trains from 146 hours of bio-acoustic probe tag data gathered from 11 tags on 8 different known individual male sperm whales. Whales were tagged while foraging around commercial longline fishing gear in the eastern Gulf of Alaska in 2007 and 2009. Clangs made up less than 1% of acoustic data on the tags, and occurred on 33% of all dives. Depths of clang production had a bi-modal distribution, with peaks from 0-20m and 180-300m. This indicates a possible multi-functional purpose of clangs, with different depth ranges being used for different purposes. Clangs were significantly more likely to be produced on the ascent phase of dives ( $p < 0.001$ ), a time when whales are otherwise silent. For each additional whale that entered the area acoustically, the tagged whale was 83% more likely to produce a clang train ( $p = 0.019$ ), and clangs were significantly more likely to occur within one minute of another whale's clang train ( $p < 0.0001$ ). These results indicate clangs may be used as a communicative signal. An increase in creak rate was significantly correlated to a 92% decrease in probability of clang occurrence ( $p < 0.001$ ). Since creak rates are an indication of foraging, this shows that clangs are probably not an important foraging tool. These results show that clangs are likely a multi-functional signal, possibly used for long-range communication, and/or group cohesion within loosely aggregated groups.



*Gulf of Alaska - Mammals*

**REPRODUCTIVE HORMONES AND VAGINAL CYTOLOGY IN CAPTIVE ADULT FEMALE STELLER SEA LIONS (*Eumetopias Jubatus*) DURING A BREEDING PROGRAM**

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The Western stock of Steller sea lions (SSLs; *Eumetopias jubatus*) is listed as endangered, and the Eastern stock is listed as threatened. Although information about adult females is necessary for understanding the population, handling of wild adult females in the United States is currently limited. Captive studies on adult female SSLs can provide valuable linear information applicable to the wild population. The Alaska SeaLife Center (ASLC; Seward, Alaska) is conducting a project investigating reproduction and maternal investment in captive adult female SSLs housed at ASLC. One portion of this project includes monitoring changes in hormones and vaginal cytology across the reproductive cycle in captive females. New assays have been validated for analyzing reproductive hormones such as estradiol (E2) in serum and progesterone (P4) in serum and feces using commercially available kits. Tests for comparisons with RIA have shown these assays to be reliable and effective for assessing hormones in SSL serum and data suggests that these methods may be more sensitive than RIA. Data elucidate key periods for confirmation of estrus and pregnancy in serum, feces and cytology.

*Gulf of Alaska - Mammals***Real-Time Acoustic Detection Of Cook Inlet Belugas For Mitigation Purposes**

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The Marine Mammal Protection Act and the Endangered Species Act require monitoring human activities to mitigate adverse impacts on Cook Inlet belugas. Multiple activities occurring in Cook Inlet (Alaska) require real-time mitigation (e.g. military activities, pile driving, oil and gas exploration and extraction, marine renewable energy). Visual monitoring has been the most widely used method for real-time mitigation because harsh environmental conditions, particularly in the upper Inlet, typically hinders the use of passive acoustics. This pilot study presents, for the first time, successful results of a real-time fully automatic continuous remote acoustic beluga monitoring method. The acoustic presence of belugas were monitored in real time over 12 days during August 2012 near the mouth of Eagle River (upper Cook Inlet), an area of conservation concern for the military due to the proposed live firing by the Joint Base Elmendorf Richardson into the adjacent Eagle River flats impact area. A shore-based PAMBuoy (Marine Instrumentation Ltd) running real time detection algorithms for both clicks (10-120 kHz) and whistles (1-20 kHz) was connected to a bottom-mounted hydrophone deployed in the mouth of the river exposed to 30 foot tides, currents over 10 knots, vegetation debris and high levels of sedimentation. Detections were successfully transmitted in real time via wireless IP data link to a station 3.2 km inland for viewing with PAMGuard software. Visual observers concurrently monitored the area for beluga presence during the daytime. Sighting distances varied from 10 to 1035 m. Output of a click rate based event detector was compared to detections selected by a human operator. The automatic system had 96% recall and 98% precision. All visual sightings (432) were acoustically detected, corresponding to 99.5% detection success, except 2 that were missed because either the whale was beyond the range of the detector or only one of two clicks very close in time was detected. These results refute the somewhat outdated belief that passive acoustics is not a suitable mitigation monitoring method for Cook Inlet belugas and further, demonstrate that automated real-time acoustic monitoring in Cook Inlet is both effective and feasible.

*Gulf of Alaska - Mammals***Seasonal Change A Stronger Influence Than Growth Upon Steller Sea Lion Behavior During Their First Winter**

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Behaviors of foraging marine predators are shaped by physical ability, foraging necessity and the environment with which they interact. We studied this interaction for 20 young-of-year Steller sea lions over their first winter in Prince William Sound, Alaska (November-April, 5–10 months age) by examining the roles of physiological development and nutritional source in development of their diving behavior. During this 143 day period (median, range 133-157), we measured changes in morphological and physiological parameters, estimated weaning status using stable isotope signatures along the vibrissae and recorded diving and haulout behavior using time-depth recorders. Sea lions of both sexes experienced similar rapid growth through their first winter (mass gain  $30 \pm 13$  kg, lipid mass gain  $18 \pm 9$  kg), with increased lipid mass contributing 58% (median, range 0-100%) of this growth. Such rapid growth is not surprising because, using visual observations and stable isotope trends, we determined all sea lions were suckling throughout their first winter. Weak interactions between physical development and diving performance during this season suggested pups were not pushing their abilities in order to forage. Most activity budget and dive characteristics were not correlated with growth, increased buoyancy due to lipid gain did not predict changes in dive ascent or descent rates and most dives ( $85\% \pm 15$ ) remained below cADL. Nonetheless, pup behavior appeared to respond to seasonal environmental cues, with a strong, significant midwinter peak in activity. These peaks in time spent submerged, vertical travel rates and dive characteristics, along with strong significant focus on nocturnal behavior, mirrored behaviors of older, more likely foraging, sea lions in the same season. Because evidence from fatty acid and stable isotope analyses indicated a shift in potential nutritional sources by winter's end, such behavioral changes may indicate increased attempts at independent prey capture by these unweaned pups.

*Gulf of Alaska - Mammals***Dental Development In A Neonatal Northern Sea Otter Pup (*Enhydra Lutris Kenyoni*)**

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Northern sea otter (NSO) pups (*Enhydra lutris kenyoni*) may be presented as live stranded animals or collected as carcasses as part of health and population assessment studies. The Alaska western population of northern sea otters has recently shown dramatic decline and was declared endangered under the Endangered Species Act in 2005 while populations in other parts of their range have remained stable (Kenai Peninsula, Prince William Sound and Washington State) or shown significant increases (southwestern Alaska). Accurate assessment of the age of live and dead stranded pups is valuable in determining rehabilitation strategies and neonatal mortality data. Records of birth dates of stranded NSO pups are rarely available so estimates of the age of the pups is usually based roughly on body size, presence or absence of natal hair coat and on presence or absence of deciduous dentition. However, these estimates can vary significantly between observers and tooth eruption times have been only reported in general terms (Tuomi, 2001) or lumped into 1 to 2 month categories (Kenyon 1969). In April 2013, a live NSO neonate was collected in Homer, AK and brought for rehabilitation to the Alaska SeaLife Center (ASLC). This pup weighed only 1.56 kg and had an easily visible fleshy pink umbilical stump, indicating that it was probably less than 24 hours of age. Dental development was documented weekly using digital photography. A pictorial chart depicting dentition at weekly intervals was developed and compared to the timing of appearance of deciduous and permanent teeth in a second stranded NSO pup with an estimated birth date that was being concurrently rehabilitated at ASLC. References: Kenyon, K.W., 1969. The Sea Otter in the Eastern Pacific Ocean, North American Fauna, No 68, pg 43-51 Tuomi, P., 2001, "Sea Otters" in: Handbook of Marine Mammal Medicine, Dierauf, L.A. and F.M.D. Gulland, eds., CRC Press, Boca Raton, FL pg. 961-988. Acknowledgements: The authors are grateful to the Rehabilitation Program staff at ASLC for the excellent care provided to the sea otter pups described in this poster and for their assistance in obtaining the photographs.

*Gulf of Alaska - Mammals***Habitat Utilization And Dive Behavior Of Resident Fish-Eating Killer Whales In Coastal And Offshore Waters Of The Gulf Of Alaska**

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Fish-eating or “resident” killer whales are apex predators in the Gulf of Alaska (GOA). Although they are potentially exposed to numerous anthropogenic stressors, especially because their diet includes many commercially important fish species, little is known about their foraging behavior in the GOA. We therefore deployed depth-transmitting LIMPET satellite tags onto 6 killer whales in northern GOA, in or near Prince William Sound (PWS), in August – September, 2011 and 2012. GOA resident killer whales are known to feed primarily on salmonids, with a preference for coho salmon, so we hypothesized that killer whale dive depths would be concentrated in the shallow waters < 100m where these fish spend most of their time in the late summer/early autumn. We received dive data for 3 to 35 days, and despite being “resident”, mean travel distances exceeded 80 km per day and covered a surprisingly large fraction of the coastal waters of the Gulf of Alaska, with movements of as much as 160 km offshore to the slope break. Some whales stayed within PWS, while others moved as far away as southern Shelikof Strait, 570 km from the tagging site. Contrary to our predictions, whales frequently made bouts of dives to between 250 and 400 m, 3 to 10 min in duration, with maximum depths for individuals ranging from 367 to 512 m. Some dive bouts appeared to be benthic while others indicated mid-water pelagic feeding. Deep dive depths and occasional benthic diving suggest that despite the evidence from analyses of fish scales collected at the surface near feeding whales, GOA resident killer whales may regularly feed on species other than salmon. However, unlike their competitor the salmon shark, we did not observe any diel periodicity in dive behavior in the early autumn, so prey may not regularly include vertically migrating species.

*Gulf of Alaska - Mammals***Factors Influencing Detection Probability Of Humpback Whales In Glacier Bay National Park And Preserve**

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Between 1978 and 2011, 108 whale-vessel collisions have been reported in Alaska and are a significant cause of whale injury and mortality (Nielsen et al., 2012). Most of these collisions (86% of those reported) have occurred between vessels and humpback whales (*Megaptera novaeangliae*) in Southeast Alaska (Nielsen et al., 2012), where a population of at least 1,585 humpbacks (Gabriele et al., 2013) overlaps with high human marine activity during the summer months. Vessel operators can attempt to avoid collisions, however this is only possible if the whale is detected with enough time to change the course or speed of the vessel. The ability to detect a whale is contingent on it being available for sighting and varies with variables such as distance, weather conditions and operating conditions of the vessel. We used whale-vessel encounter data to investigate factors that influence detection probability of humpback whales in Glacier Bay National Park and Preserve. Shipboard observers recorded encounters between humpback whales and cruise ships from 2006 to 2012, collecting information on distance, behavior, direction and orientation of the whale, weather covariates and operating conditions of the ship. Under the assumptions of distance sampling theory (Buckland et al., 2001), we estimated the probability of detection as a function of distance between the observer and whale and examined the potential effects of visibility, sea state, and ship speed on detection probability. Probability of detection decreased markedly after 500m distance and both visibility and sea state both significantly affected probability of detecting whales. Awareness of these conditions that lower detection probability will allow vessel operators to more actively avoid and reduce the likelihood of potential collision situations.

*Gulf of Alaska - Mammals***Does Diversity Matter? Understanding The Link Between Population Change And Diet Diversity In Steller Sea Lions.**

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Diet appears to play an important role in the population trajectories of Steller sealions (*Eumetopias jubatus*) as higher rates of growth have historically been correlated with higher levels of diet diversity. We examined spatio-temporal changes in the diets of sea lions in Southeast Alaska, and modeled relationships between population growth and diet diversity. Our goal was to determine whether differences in the growth rates of rookeries and the establishment of new rookeries could be explained by changes in diet. Sea lion scats were collected from 2000-2010 at rookeries (n=2308) and haulouts (n=1554) in Southeast Alaska, and prey species were identified from recovered hard parts. We grouped the prey species into 8 categories (gadids, forage fishes, salmon, rockfish, flounders, cephalopods, hexagrammids, and other species) and calculated dietary diversity from these groupings using split-sample frequency of occurrence and the Shannon-Wiener index. On a diversity scale of 1 to 8, we found that sea lions occupying rookeries during summer had a higher diet diversity (dd=5.3) than individuals occupying haulouts during other times of year (dd=3.8). We also found that diet diversity increased over time (years) at sites that transitioned from being haulouts to becoming rookeries. For example, diet diversity at Graves Rocks was 4.4 in 1994 before pups were born (n=48 scats), and was 7.0 in 2004 when reclassified as a rookery (n=55). Overall, there was a strong, positive relationship between diet diversity and the rates of change of sea lion numbers at rookeries (SE Alaska) and across regions of Alaska between 1990-1994 and 2002-2004. Diet diversity appears to be a proxy for energy density (i.e., less diverse diets were dominated by low energy prey groups) and suggests that quality of diet is closely linked to population change of sea lions on both small (e.g., between rookeries) and large scales (e.g., between populations).

*Gulf of Alaska - Mammals***Preliminary Results For Harbor Seal (*Phoca Vitulina*) Vibrissae Growth Rates And Molt Schedules**

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Analysis of serial sections of harbor seal vibrissae (whiskers) can create a temporal record of diet and hormones. In order to interpret vibrissae analysis, growth rate and molt schedule must first be defined. We marked 14 vibrissae on 4 captive harbor seals housed at the Alaska SeaLife Center: 1 adult male, 1 adult female, 1 juvenile male, and 1 juvenile female. Seven vibrissae from the ventral and caudal quadrant of each cheek were selected because these were the longest and contain the most material for analysis. Two crimping beads were affixed to each vibrissa between March 20 and May 1, 2013. A second set of beads were added once vibrissae were lost due to molt and a replacement vibrissa began to regrow. The seals were trained to place their muzzle through a hole in a board, and digital photographs were obtained weekly. A piece of measuring tape was affixed to the board for calibration and various length measurements on each vibrissa were collected using ImageJ. Slow growth was measured from the beginning of the study until each vibrissa molted and averaged  $0.27 \pm 0.08$  mm/day (n=42); fast growth was measured post molt and averaged  $0.73 \pm 0.07$  mm/day (n=42). These values agree with previous growth rate studies on harbor seal vibrissae. Abrasion rates averaged  $0.11 \pm 0.05$  mm/day (n=67). Molt schedule was difficult to measure; the juvenile male did not cooperate often enough to track molt and the adult male lost vibrissae throughout the study period. He was also found with facial wounds after fighting with another adult male and may have lost some vibrissae due to injury instead of molt. The 2 female harbor seals molted all of their marked vibrissae during a small window of time, 28 days (July 24-Aug 21) for the adult and 33 days (May 31-July 3) for the juvenile; both just prior to predicted pelage molt for the cohort. Also, a pattern of molt was evident with the outermost vibrissae being molted first, leading us to believe that vibrissae may molt progressively along the muzzle from the outer cheek toward the nose.



*Gulf of Alaska - Mammals***Heart Rate During Diving Activities In Free-Ranging Harbor Seals (*Phoca Vitulina*)**

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The energetic consequences of disturbance to harbor seals have not been quantified. Behavioral studies often use entry into water to define disturbance, although seals often enter the water even when not disturbed. One approach to studying disturbances may be to use heart rate (HR) loggers since HR can be used as an index of energy expenditure. During May 2008-2010, time depth recorders (TDRs) and HR monitors were attached to 22 harbor seals in Endicott Arm, Southeast Alaska. Mean body mass was  $44.4 \pm 2.0$  kg and paired HR and dive data were collected for 12-69 days. Diving activity was divided into 4 phases, descent, bottom, ascent, and post-dive surface interval (PDSI) – the period on the surface between dives. Average HR during descent was  $46.0 \pm 1.8$  beats per minute (bpm),  $48.1 \pm 1.8$  bpm at the bottom of the dive,  $51.9 \pm 1.9$  bpm during ascent, and  $102.7 \pm 4.0$  bpm during the PDSI. The influence of body mass and dive duration on mean HR across the diving phases was examined using a linear mixed effects model with animal as a random effect. During the PDSI mean HR was significantly higher ( $p < 0.001$ ) than during other phases, however there was no difference in HR during phases within the dive. Overall Mean HR was negatively associated with dive duration ( $p = 0.021$ ), however, this effect became increasingly positive with dive duration during ascent and PDSI ( $p = 0.018$  and  $p < 0.001$ ). There was a significant interaction between mass and duration during the descent, ascent and the PDSI. This effect was such that with increasing dive duration, larger animals appeared to increase their HR more during descent ( $p = 0.024$ ), but less during ascent ( $p = 0.024$ ) and PDSI ( $p < 0.001$ ). This suggests during longer dives, seals had a more profound dive response, and may also experience a slight anticipatory tachycardia. The significant effects of mass may be explained by larger seals working harder during dive descent but having less need for an anticipatory response or recovery after dives. These data suggest that HR shows promise as a tool to quantify the additional diving costs incurred when harbor seals experience disturbances..

*Gulf of Alaska - Mammals*

**Killer Whale Acoustic Presence And Call Characteristics in The Gulf Of Alaska:  
Inferring Ecotype From Acoustic Repertoire**

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Transient and resident killer whales in the Gulf of Alaska occupy distinct ecological niches. These ecotypes have diverged genetically and behaviorally and may be considered as separate species in the future. Killer whale pods maintain stable acoustic repertoires that vary between ecotypes and individual pods, creating the potential for autonomous acoustic recording to be used as a tool in studying distribution and movements of the species, as well as various ecotypes. Acoustic data from two sites: one on the continental slope south-southwest of the Prince William Sound, and another on Pratt Seamount in the central Gulf of Alaska have been analyzed for the presence of killer whale sounds between fall 2012 and early winter 2013. Killer whale vocalizations occurred in fall and winter at both sites, although less commonly farther offshore. We present preliminary analyses of their acoustic repertoire at both locations. Call types are compared with previous descriptions of transient and northern resident killer whale sounds to look for similarities that might suggest which ecotypes are present in these areas at times of year when little data exists on their distribution.

*Gulf of Alaska - Mammals***Testing A Citizen Science Model For Humpback Whale Data Collection, Monitoring, And Industry Involvement In Southeast Alaska**Suzanne Teerlink, [steerlink@alaska.edu](mailto:steerlink@alaska.edu)Larissa Horstmann-Dehn, [dehn@sfos.uaf.edu](mailto:dehn@sfos.uaf.edu)

Humpback whales (*Megaptera novaeangliae*) are socially, ecologically, and economically important to southeast Alaskan communities. The aim of this project was to gain a comprehensive understanding of humpback whales using waters adjacent to the community of Juneau that are subject to extensive whale watching tourism, while simultaneously including the industry stakeholders in the process. We developed a hands-on educational and collaborative citizen science program where Juneau whale-watching industry volunteers participate in the scientific process during their tours. In this study, fluke identification photos and associated data (e.g., time, date, location, etc.), necessary to monitor humpback whales, were taken and images were matched by volunteers to involve industry and tourists in research. This method utilizes existing platforms and interested volunteers to greatly reduce costs associated with humpback whale monitoring surveys. These data are potentially useful to describe the Juneau area humpback whale population in terms of abundance (using mark-recapture), site fidelity, and area-use. To test the validity of citizen science data collection methods for use in these analyses, we conducted traditional monitoring surveys in the same area during the same time. We then compared the results from the citizen science dataset to the results from our parallel traditional surveys, where our traditional survey results could act as a control. This allowed us to objectively address the potential issues with data collected by whale watching industry volunteers compared with our own more traditional survey approach. Discrepancies from biases inherent in these data collection methods are described, as well as considerations scientists can make to succeed in their own citizen science endeavors. This study serves as an example of how interdisciplinary connections can be made in research and paves the way for future industry-driven citizen science programs to engage and educate non-scientists in science questions, techniques, and culture.

*Gulf of Alaska - Mammals***Photo-Identification Of Beluga Whales In Eagle Bay, Knik Arm, Upper Cook Inlet, Alaska.**

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In 2009, JBER submitted a biological assessment proposing resumption of year-round artillery and mortar firing into the Eagle River Flats, adjacent to Eagle Bay of Knik Arm. The Biological Opinion prepared by NMFS recommended continued photo-identification of Cook Inlet belugas (CIB). The Photographic Identification of CIB in Eagle Bay Study had two objectives: •Document individual CIB usage of Eagle Bay; •Assess/ monitor relative health of CIB in Eagle Bay. Photo-id surveys were conducted 2005-2011 in Upper Cook Inlet. Sighting histories were compiled for all CIB photographed in Eagle Bay in order to examine residency and movement patterns with emphasis on CIB identified in Eagle Bay in 2011. This study provides evidence that most, and perhaps all, of the CIB population uses Eagle Bay seasonally. Sighting records in the 2005-2011 CIB photo-id catalog indicate that 78% of the 307 identified CIB have used this area at least once. One whale was re-sighted in Knik Arm nine times within the same field season. Ninety percent of the identified whales in the 2005-2011 catalog that were seen in Eagle Bay were also seen elsewhere in Upper Cook Inlet. Surveys indicated Eagle Bay is used seasonally by groups with calves and newborns. Sighting histories underscore the use of Eagle Bay by reproductive females and their calves: 58% of whales identified here in 2011 were presumed to be reproductive females based on sighting records in the 2005-2011 catalog, and 39% were seen here with calves in 2011. Marks were used to assess relative health of whales in Eagle Bay, and were classified as infection, general trauma, rake marks, molting, satellite tag scars, puncture wounds, entanglement, pigment, or mud/silt. All CIB identified in Eagle Bay in 2011 displayed rake marks, and 62% of CIB in Eagle Bay had signs of infection. One live whale showed signs of rope entanglement. When considering the possible effects on CIB from anthropogenic activities in Knik Arm, we note that most, and possibly all, of the CIB population (including calves and neonates) could be seasonally exposed to these activities, and that the same individuals may be exposed multiple times annually.

*Gulf of Alaska - Mammals***Photo-Identification Of Beluga Whales In The Susitna River Delta, Upper Cook Inlet, Alaska, 2005-2012.**

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The Cook Inlet Beluga Whale (CIBW; *Delphinapterus leucas*) Photo-identification Project has demonstrated that endangered CIBWs possess distinct natural marks that can be photographed and used to identify and track individuals. The 2005-2011 catalog contains records for 307 individuals. Although some individuals have likely died and many calves have not yet been identified, nevertheless the catalog contains sighting histories for the majority of the CIBW population (estimated at 284 by NMFS in 2011). This poster summarizes results from photo-identification surveys of Upper Cook Inlet 2005-2012, with emphasis on results from 152 groups encountered in the Susitna River Delta (photos from 2012 not yet cataloged). The largest beluga groups encountered during surveys of Upper Cook Inlet were found in the Susitna River Delta. Seasonally, CIBW groups in the Susitna River Delta were large in mid-late May, smaller in June through mid-July, then peaked in late July through mid-August. These large groups (ca. 200 whales) were observed travelling, socializing, and were suspected to be feeding. Groups did not appear to be segregated by color or age-class, and most of the groups encountered contained both white and gray whales. Calves and neonates made up a slightly lower percentage of groups seen in the Susitna River Delta in 2011 and 2012 compared to groups seen there in previous years. Our multi-year observations indicate that calving for CIBWs began in mid-to late July/early August and the first neonates of the season are seen at the Susitna River Delta, although neonates have been seen in other areas of Upper Cook Inlet. Identified CIBWs photographed in the Susitna River Delta 2005-2011 were also photographed during surveys of Knik Arm, Chickaloon Bay, Turnagain Arm, and the Kenai River. The Susitna River Delta is an important area for CIBW feeding, socializing, and for groups with calves. The largest groups in Cook Inlet are found here seasonally, the first neonates of the season are found here, the earliest large feeding groups of the ice-free season are found here, and identified individual whales return here year after year.

*Gulf of Alaska - Mammals***Distribution Of Sperm Whales, *Physeter Macrocephalus*, From Soviet Catches In The North Pacific, 1963-71**

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Data from Soviet whaling (much of it illegal) conducted in 1963-71 in the North Pacific (NP) were analyzed to investigate the distribution of sperm whales. Formerly secret whaling reports provided details of catch distribution and composition, involving 53,168 whales (although 5,302 could not be assigned to area). Using two lines of longitude (160°E and 160°W), the Soviets divided the NP into three regions: Eastern Region (ER), Central Region (CR) and Kurils (including northern Japan). Catches were 20,652 (ER), 15,335 (CR), and 6,581 (Kurils). Other catches included the Aleutians (1,864) and Commander Islands (2,119), pelagic Bering Sea (586), Oleutorskiy Bay (207) and other parts of the pelagic NP (522). Four main areas of catch concentration are evident: a large pelagic area (30-50°N) in the ER, including the Gulf of Alaska and western coast of North America; the northeastern and southwestern portions of the CR; and the southern Kurils/northern Japan. Some of the distribution was similar to the geographically more limited 19th century catches plotted by Townsend, with a notable concentration in the "Offshore Ground" in the western Pacific. Where known, sex ratio was distributed as follows: ER 12,759 females, 6,552 males; CR 8,857 females, 5,435 males; Kurils 4,139 females, 2,354 males; Aleutians 55 females, 295 males. The Bering Sea catch had only 1 female and 442 males, but there were a surprising number of females caught in the higher-latitude areas of Oleutorskiy Bay (32, versus 34 males) and the Commander Islands (509, versus 300 males). Reproductive status of mature females in the three main areas (ER, CR and Kurils) was generally similar: pregnant 10.9-51.1% (mean 35.3%), resting 13.6-77.8% (mean 44.5%), lactating 5.4-45.5% (mean 20.6%). Overall more than 92,000 sperm whales were killed in 9 years, representing 58% of the total catch over a 30-year period. The majority of females were killed during the 6-year period 1965-71; this mainly illegal removal of a large portion of the reproductively active population was reflected in an obvious decline in catches in the ER by 1969, followed by the CR and Kurils. (Funded by NPRB).

*Gulf of Alaska - Seabirds***Long-Term Diet Patterns Of Black Oystercatchers (*Haematopus Bachmani*) In The Gulf Of Alaska**

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Black oystercatchers (*Haematopus bachmani*) are a species of concern throughout their range because of their specialized habitat and small population size. The prey base of black oystercatchers, which consists of animals found in the intertidal zone, may shift in unknown ways as a result of climate change. To better understand the intra-season and long-term diet patterns of black oystercatchers, we analyzed whole blood and feathers of black oystercatchers as well as several species of potential prey items using carbon ( $^{13}\text{C}$ ) and nitrogen ( $^{15}\text{N}$ ) stable isotopes. Blood and feather samples were collected from several field locations in the northern Gulf of Alaska in 2012 and 2013. Additionally, archived blood collected in the early 2000s and archived feathers collected throughout the 1900s in the same locations were also analyzed. Potential prey items were collected during 2012 and 2013 field efforts. Mixing models suggest that the diet of individuals sampled in 2012 and 2013 is approximately 52% mussels or other filter feeders, 41% limpets or other grazers, and approximately 5% dogwinkles or other secondary consumers, which is consistent with previous assessments of diet. There was little variation in the intra-season  $^{13}\text{C}$  and  $^{15}\text{N}$  signatures of feathers and of blood among individuals, suggesting the sampled individuals share a similar, specialized diet throughout the spring and summer seasons. Additionally, initial results of archived feathers show similar  $^{15}\text{N}$  values as those of recently sampled individuals, suggesting a long-term pattern of feeding at the same trophic level. Our results indicate that black oystercatchers may be susceptible to changes in the species composition of the intertidal zone.

*Gulf of Alaska - Seabirds*

**Perusing The Past: 4000 Years Of Carbon And Nitrogen Stable Isotope Data From Cormorant In The Gulf Of Alaska**

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Analyses of stable carbon and nitrogen isotopes (SI) are used widely in paleoecological research for reconstructing prey sources, trophic levels and past productivity. Here we present SI from collagen extracted from archaeological bone collagen of at least three species of cormorant (pelagic, *Phalacrocorax pelagicus*; red-faced *Phalacrocorax urile*; and double crested *Phalacrocorax auritus*). All 280 samples derive from archaeological sites on Sanak Island and span over 4000 years. Mean  $\delta^{15}\text{N}$  is  $17.51 \pm 1.99\text{‰}$  (with a range of 13.68‰ to 20.3‰  $\delta^{15}\text{N}$ ) and mean  $\delta^{13}\text{C}$  is  $-13.17 \pm 1.50\text{‰}$  (with a range of -17.39‰ to -11.04‰). These wide ranges are due to several factors including; differing prey of the three cormorant species discussed, changes through time in prey, and changes through time in foraging locations. This is the largest data set of its kind for cormorant and provides new perspectives regarding stability of cormorant trophic dynamics over time.



*Gulf of Alaska - Seabirds*

**Using Remote Methods To Study Black-Legged Kittiwake (*Rissa Tridactyla*) Productivity In The Gulf Of Alaska**

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The productivity of seabirds has been considered a potential indicator of their local environmental conditions. Productivity typically fluctuates with changes in climate or community structure, making seabirds a source of scientific interest for monitoring the marine environment. Black-legged kittiwakes (*Rissa tridactyla*, kittiwake) are of particular interest in the North Pacific due to their abundance and propensity to nest in highly visible locations during the breeding season. To examine the suitability of utilizing kittiwake productivity as a link to local community and environmental conditions, the overarching goal of this project is to investigate factors that influence kittiwake productivity in the Gulf of Alaska and the degree of importance each aspect has on productivity. The objective of the first phase of this project is to determine how differences between physical attributes of nests and behavior of breeding pairs affect productivity. Productivity data were collected from a sub-colony of kittiwakes in Resurrection Bay near Seward, Alaska via a remote-control video system. Video was recorded twice a day May through August for the breeding season of 2013. Archived video, recorded May through August twice a week from 2010-2012, will be reviewed for breeding behaviors and productivity while high quality still images will be used to analyze physical attributes of nest sites. Covariates being tested for their influence on nest success include presence of adults at nests, annual variation in the onset of incubation, structural characteristics and locality of nests, and behavior of adults throughout the breeding season.